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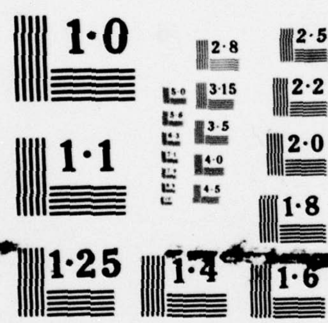

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DREDGE DISPOSAL STUDY

SAN FRANCISCO BAY AND ESTUARY

AD A071722

LEVEL III

APPENDIX B

POLLUTANT DISTRIBUTION

 MAY 1979

DREDGE DISPOSAL STUDY
FOR
SAN FRANCISCO BAY AND ESTUARY

APPENDIX B

POLLUTANT DISTRIBUTION STUDY

MAY 1979

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
211 MAIN STREET
SAN FRANCISCO, CALIFORNIA 94105

FOREWORD

In April 1972, the San Francisco District of the United States Army Corps of Engineers initiated a study to quantify the impact of dredging and dredged sediment disposal operations on the environment of San Francisco Bay and Estuary. The study has generated factual data, based on field and laboratory studies, needed for the Federal, State and local regulatory agencies to evaluate present dredging policies and alternative disposal methods.

The study was set up to isolate the questions regarding the environmental impact of dredging operations and to provide answers at the earliest date. The study was organized to investigate (a) the factors associated with dredging and the present system of aquatic disposal in the Bay, (b) the condition of the pollutants (biogeochemical), (c) alternative disposal methods, and (d) dredging technology. The study elements were intended first, to identify the problems associated with dredging and disposal operations and, second, to address the identified problems in terms of mitigation and/or enhancement. The division into separate but interrelated study elements provided a greater degree of expertise and flexibility in the Study.

The Main Report was published in February 1977. This report is the last remaining appendix to be published. The report covers an analysis of contaminant concentrations as they relate to types of sediment, deposition regimes (spatial variations) and temporal variations. The analysis utilized routine sampling by the Corps of Engineers and others and specific sampling based on seismic profiling.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Appendix B	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (6) Dredge Disposal Study. San Francisco Bay and Estuary. Appendix B. Pollutent Distribution Study. AD38 310		5. TYPE OF REPORT & PERIOD COVERED (9) Final rept. 6. PERFORMING ORG. REPORT NUMBER - -
7. AUTHOR(s) (10) Richard M. Ecker John F. Sustar John Hendricks		8. CONTRACT OR GRANT NUMBER(s) - -
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, San Francisco 211 Main Street San Francisco, CA 94105		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS (11) May 79
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, San Francisco 211 Main Street San Francisco, CA 94105		12. REPORT DATE June 1979 13. NUMBER OF PAGES 497
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) (12) 509p		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dredging
Estuary
Environmental Impact
Sediments
Seismic Profiling
Contaminant Levels

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The report presents an analysis of spatial and temporal distribution of contaminants in select areas of San Francisco Bay. Sedimentary processes are described, previous sampling is analyzed and levels of contaminants are discussed in terms of location, strata, sediment type and sources of contaminants.

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The following is an index of appendices in the Dredge Disposal Study:

APPENDEX	REPORT	DATE PUBLISHED	NTIS NUMBER PRICE CODE*
-	MAIN REPORT	FEB 1977	AD-A037 727/SWP or AD-A038 308/3WP PC A06/MF A01
A	MAIN SHIP CHANNEL (SAN FRANCISCO BAR)	JUN 1974	AD-A038 309/1WP PC A10/MF A01
B	POLLUTANT DISTRIBUTION	MAY 1979	
C	WATER COLUMN (WATER COLUMN - OXYGEN SAG)	APR 1976	AD-A038 310/9WP PC A09/MF A01
D	BIOLOGICAL COMMUNITY	AUG 1975	AD-A037 728/3WP PC A20/MF A01
E	MATERIAL RELEASE	AUG 1977	AD-A043 790/5 GI
F	CRYSTALLINE MATRIX	JUL 1975	AD-A037 542/8WO PC A12/MF A01
G	PHYSICAL IMPACT	JUL 1975	AD-A038 311/7WP PC A10/MF A01
H	POLLUTANT UPTAKE	SEP 1975	AD-A037 543/6WO PC A08/MF A01
I	POLLUTANT AVAILABILITY	OCT 1975	AD-A038 312/5WP PC A15/MF A01
J	LAND DISPOSAL	OCT 1974	AD-A038 313/3WP PC A18/MF A01
K	MARSH DEVELOPMENT	APR 1976	AD-A037 544/4GI PC A19/MF A01
L	OCEAN DISPOSAL	SEP 1975	AD-A038 314/1WP PC A06/MF A01
M	DREDGING TECHNOLOGY	SEP 1975	AD-A038 315/8WP PC A17/MF A01
N	ADDENDUM	SEP 1978	

*National Technical Information Services, U.S. Department of Commerce, Springfield, VA 22161

CONVERSION FACTORS

If conversion between Metric and British systems is necessary, the following factors apply:

LENGTH

1 kilometer (km)=10^3 meters=0.621 statute miles=0.540 nautical miles
1 meter (m)=10^2 centimeters=39.4 inches=3.28 feet=1.09 yards=0.547 fathoms
1 centimeter (cm)=10 millimeters (mm)=0.394 inches=10^4 microns (μ)
1 micron (μ)=10^{-3} millimeters=0.000394 inches

AREA

1 square centimeter (cm^2)=0.155 square inches
1 square meter (m^2)=10.7 square feet
1 square kilometer (km^2)=0.386 square statute miles=0.292 square nautical miles

VOLUME

1 cubic kilometer (km^3)=10^9 cubic meters=10^{15} cubic centimeters=0.24 cubic statute miles
1 cubic meter (m^3)=10^6 cubic centimeters=10^3 liters=35.3 cubic feet=264 U.S. gallons=1.308 cubic yards
1 liter=10^3 cubic centimeters=1.06 quarts=0.264 U.S. gallons
1 cubic centimeter (cm^3)=0.061 cubic inches

MASS

1 metric ton=10^6 grams=2,205 pounds
1 kilogram (kg)=10^3 grams=2.205 pounds
1 gram (g)=0.035 ounce

SPEED

1 knot (nautical mile per hour)=1.15 statute miles per hour=0.51 meter per second
1 meter per second (m/sec)=2.24 statute miles per hour=1.94 knots

TEMPERATURE

Conversion Formulas $\quad °C = \dfrac{°F-32}{1.8} \quad\quad °F = 1.8(°C) + 32$

DREDGE DISPOSAL STUDY
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DREDGE DISPOSAL STUDY
FOR
SAN FRANCISCO BAY AND ESTUARY

APPENDIX B

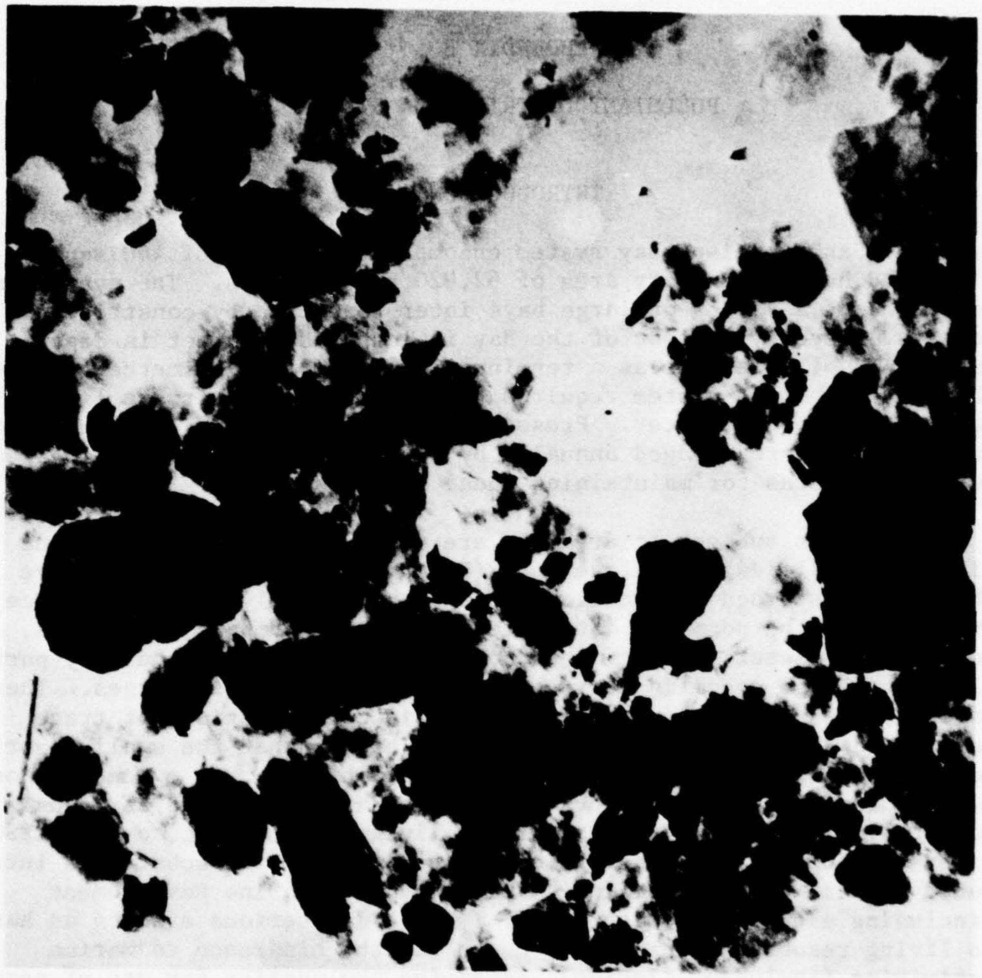
POLLUTANT DISTRIBUTION STUDY

INTRODUCTION

The San Francisco Bay system encompasses an area of 460 square miles and has a tributary area of 62,920 square miles. The system is comprised of a series of large bays inter-connected by constricted straits. Seventy percent of the Bay is less than 18 feet in depth. The importance of this area as a terminus for waterborne commerce and the shallowness of the system requires the dredging of waterways linking the major ports to deep water. Presently, about 10 million cubic yards of Bay sediments are dredged annually by the Federal Government, local and private concerns for maintaining these channels.

Sediments subject to dredging are composed largely of the fine silt-clay-colloidal size fractions (Figure 1). The electronegative charge of dispersed clay colloidals and their highly exposed surface areas permit the sorption (attachment) of large numbers of cations. The sorptive characteristics of most contaminants are great and clay particles have large specific surfaces with electronegative charges. Therefore, dredged sediments invariably contain concentrations of trace metals and organics at levels many times higher than the small quantities found in water. When the sediments contain high enough concentrations of organic and inorganic contaminants they are classified as being polluted. The definition of marine pollutants according to the UNESCO Inter-governmental Oceanographic Commission (IOC) is "substances introduced by man, directly or indirectly, into the marine environment (including estuaries) which result in such deleterious effects as harm to living resources, hazards to human health, hindrance to marine activities (including fishing), impairing the quality for use of seawater and reduction of amenities." Contaminants, when attached to marine sediments, behave as the sediments, so when dredging and disposal operations resuspend and disturb the bottom sediment regimen, the contaminants are also disturbed and may become available to the benthic and aquatic communities.

The association of contaminants with the sediments is dependent on the physical sedimentary characteristics of the estuary and the forces that distribute the sediments. The transportation and deposition of fine sediments and sorbed contaminants involve complex relationships



ELECTRON MICROGRAPH
SILT-CLAY-COLLOIDAL

SOURCE: KRONE, 1974.

FIGURE 1

such as tidal flow velocities and mixing characteristics, suspension concentrations and deposition patterns. The concentration of any given contaminant differs greatly both spatially and temporally.

Sampling bottom sediments and analyzing the pollutional characteristics in the San Francisco Bay was begun by the Corps of Engineers in December 1970. The first sampling took place on San Francisco Bay near the entrance to the Bay and was performed for maintenance dredging in the Bay Channel (Main Ship Channel, Ref. 1). Since then the Corps has amassed a vast amount of data on the pollution status of sediments in the Bay. All of the sampling by the Corps prior to this study was in the channels and was directly related to maintenance or new-work dredging.

Methods and procedures for sampling bottom sediments and analyzing the pollutional status of these sediments have become increasingly complex. Initial pollution sampling in the Bay utilized bottom grab or shallow gravity core samplers. The samples obtained with this equipment were homogenized and analyzed according to "criteria" or guidelines for the acceptability of dredged material for aquatic disposal which were specified at that time by regulatory agencies. The initial "criteria" developed by the Environmental Protection Agency included bulk sediment analysis of three heavy metals (mercury, lead, and zinc) and four organic determinations (Kjeldahl nitrogen, chemical oxygen demand, oil and grease, and volatile solids). Since that time procedures for taking samples and analyzing samples have changed frequently. It was soon realized that shallow sediment samples may not represent the actual sediments subject to dredging since there likely exists a temporal variation in concentration of pollutants as exhibited by vertical variations of both sediment characteristics and contaminant concentrations. In January 1971 sampling methods were altered to obtain a representative sample to project depth. Deeper core samplers were used to sample to the required depth. Initially, the entire length of the deeper cores were homogenized and a sample was allocated for analysis using the same "criteria" as described above. It was then determined that trace metals and other contaminants may be associated with and concentrated in the silt-clay-colloidal particle size fractions and organics of the bottom sediments (Ref. 2). Based on this premise, samples were selected from each core according to stratification of the core or in the absence of horizons, at set intervals along the core. Other methods of sediment analysis were attempted at this time such as silt-clay-colloidal separation on an experimental basis; however, these methods proved to be too time consuming and costly.

STATEMENT OF PROBLEM

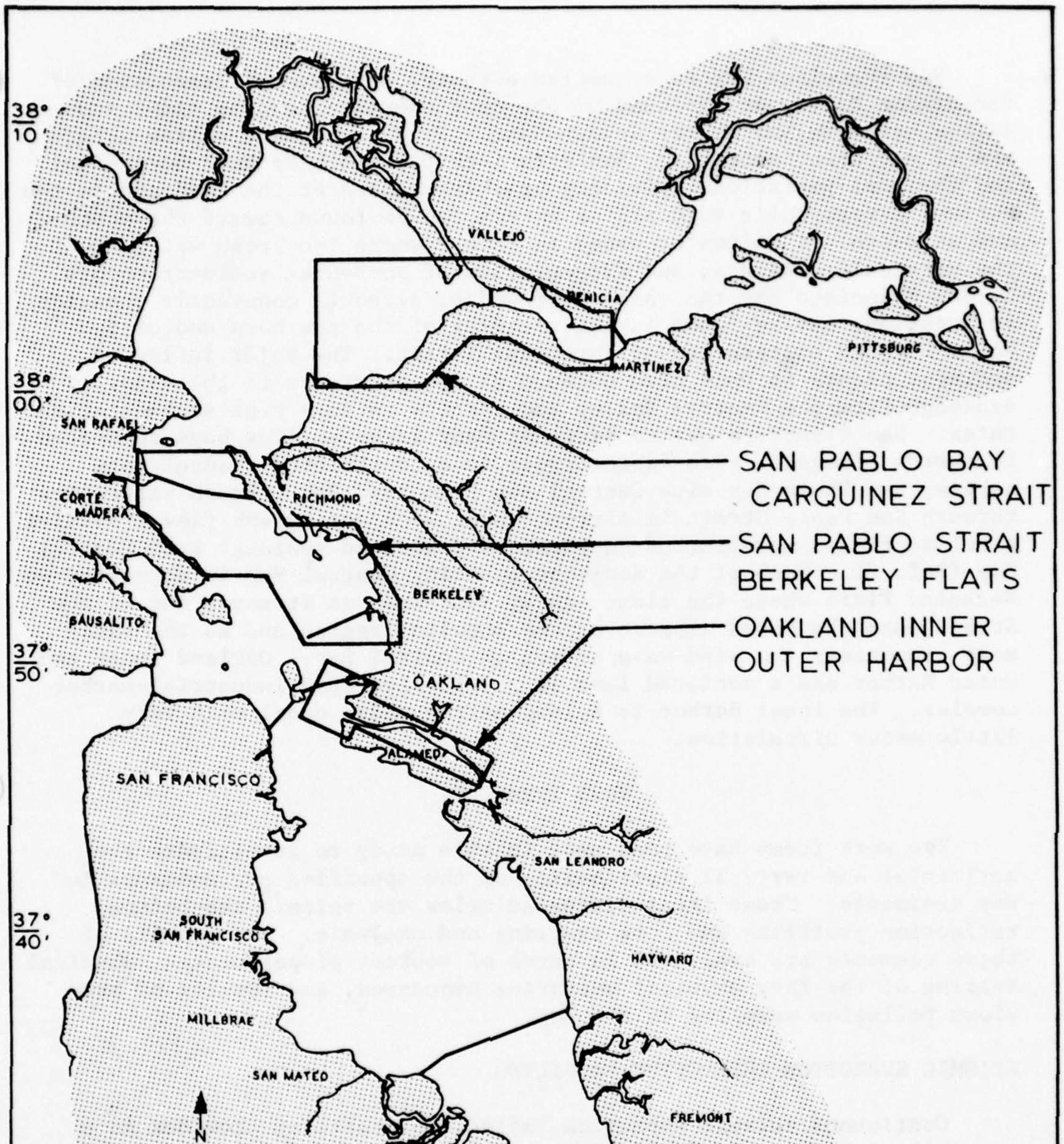
Pollution sampling of bottom sediments by the Corps of Engineers in San Francisco Bay in the past had been conducted annually on a project by project basis. No attempt has been made to develop organized pollution sampling programs in the Bay or to analyze the spatial or temporal variation of contaminant concentrations on a project or Bay-wide basis. Previous pollution sampling by the Corps had been confined strictly to dredged channels. No attempt had been made to correlate the pollutional status of sediments outside the dredged channels to the sediments within. Dredged channels represent possible settling basins for sediments whose contaminant concentrations are derived in part before the sediments are brought into the Bay system, when in residence outside the channel and after being deposited in the channels. Questions arise as to the changes in temporal and spatial variations of contaminants and the relationship of contaminant concentrations in and outside of maintained channels and mechanisms responsible for the distribution.

OBJECTIVE

The objective of the Pollutant Distribution Study is to investigate the horizontal (spatial) and vertical (temporal) distribution of certain organic and inorganic contaminants in the Bay sediments. The vertical distribution includes the vertical variation in concentration of contaminants within the bottom sediments and the association with the vertical and horizontal stratification of sediments. The horizontal distribution includes the lateral variation in concentration of contaminants and the association with the physical characteristics of the sediment. This study synthesizes previous pollution sampling and analysis of bottom sediments, by the Corps and others, interprets the data, and includes the findings into this investigation. An investigation of the physical estuarine processes and physical factors affecting the distribution of contaminants is made to provide a simplified physical picture of contaminant dispersion patterns. The trace metals (mercury, lead, zinc, cadmium, and copper) and organics (volatile solids, Kjeldahl nitrogen, and oil and grease) and chemical oxygen demand are the parameters selected for analysis. This study deals with only the above parameters and how they are associated with the bottom sediments and distributing forces. Other appendices of the Dredge Disposal Study deal with sediment-water relationships and availability of contaminants.

STUDY AREAS

Three areas were chosen to represent the range of conditions likely to be encountered during dredging in San Francisco Bay. The three areas considered in this study are San Pablo Bay-Carquinez Strait, San Pablo Strait-Berkeley Flats, and Oakland Inner and Outer Harbor (Figure 2).



38° 10'
38° 00'
37° 50'
37° 40'
37° 30'
122° 30'
122° 20'
122° 10'
122° 00'
VALLEJO
BENICIA
MARTINEZ
PITTSBURG
SAN RAFAEL
CORTE MADERA
RICHMOND
BERKELEY
SAUSALITO
OAKLAND
ALAMEDA
SAN FRANCISCO
SAN LEANDRO
SOUTH SAN FRANCISCO
HAYWARD
MILLBRAE
SAN MATEO
FREMONT
REDWOOD CITY
PALO ALTO
ALVISO
N
1 0 1 2 3
SCALE
SAN PABLO BAY
CARQUINEZ STRAIT
SAN PABLO STRAIT
BERKELEY FLATS
OAKLAND INNER
OUTER HARBOR

FIGURE 2

San Francisco Bay is a complex estuary, a region of transition of freshwater inflow at its head to the continuously changing tides and saline water inflow at the Golden Gate. Since fresh and saline waters are of different densities, San Francisco Bay exhibits both horizontal and vertical variations, yielding brackish waters at the head and in the surface waters while more saline waters can be found toward the mouth and at depth. A saltwater wedge is formed where the fresh waters meet the more saline waters, and flocculation of suspended sediment occurs. In San Francisco Bay the salt water wedge, although constantly changing in location, may be found in the vicinity of the southern end of San Pablo Bay and eastern end of Carquinez Strait. The major inflow of sediment occurs in this area because of its proximity to the major drainage from the Central Valley and results in very high sedimentation rates. San Francisco Bay consists of many large shallow bays connected by narrow channels. San Pablo Strait is a constricted channel connecting San Pablo Bay with Central San Francisco Bay. Fresh water flow through San Pablo Strait is directed southward during ebb flow providing a net southward movement of suspended and bedload sediment into Central Bay (Ref. 3). Much of the sediment entering Central Bay is deposited on Berkeley Flats where the tidal energy decreases as it moves out of the Strait onto the broad expanse of the shoaling region and as the water mass encounters the wind-wave action in Central Bay. Oakland Inner and Outer Harbor and associated land is a well-developed industrial-harbor complex. The Inner Harbor is a long narrow tidal canal with very little water circulation.

WORK ITEMS

Two work items have been used in this study to investigate the horizontal and vertical distribution of the specified contaminants in Bay sediments. These items discussed below are seismic sub-bottom reflection profiling and core sampling and analysis. The results of these elements are evaluated in terms of sources of pollutants, physical setting of the Bay, physical estuarine processes, and results of previous pollution sampling in the Bay.

SEISMIC SUBBOTTOM REFLECTION PROFILING

Continuous seismic subbottom reflection profiling provides in a vertical plane a geological cross-section of the subbottom below the path traversed by an operating vessel. The theory of operation of a seismic reflection system is to generate a pulse configuration of outgoing acoustic signals from an energy source which is reflected off bottom and subbottom interfaces due to the change in the acoustic impedance of different sediments and then returned to the surface where

the signal is received by an array of hydrophones, processed, and recorded on a continuous recorder. The subbottom penetration and resolution are dictated by the frequency and intensity of the acoustic signal. A low frequency, high energy system allows deep penetration-low resolution whereas a high frequency, low energy system permits shallow penetration with high resolution. The seismic reflection method utilizes the effect that a geological discontinuity has upon the transmission of sound waves between two media. The discontinuity may be an abrupt change in acoustical properties of the sediments or it may be a zone of very rapid change in these properties. Changes in sediment densities or water content within a sediment layer produces a reflecting surface because of the change in acoustic impedance.

With the use of this method it is often possible to differentiate areas of soft clays and silts from areas of dense sand or to discern and follow bedding. Acoustic systems have been demonstrated on several occasions to significantly reduce the scope of drilling programs permitting correlation of horizons between borings by other than a "straight line" method.

Approximately 156 miles of continuous seismic subbottom profiling, encompassing an area of approximately 275 square miles was performed by Alpine Geophysical, Inc., under contract to the Corps of Engineers in the three areas of interest in the Bay. The purpose of the program was to locate areas where core samples would be required based on differences in sediment characteristics and to associate defined horizons within the sediment column which could be traced laterally. Because of the changing subbottom characteristics of the Bay, three independent systems shown on Figure 3 were utilized to accomplish the investigation.

One system used in the seismic reflection work was a 3.5 KHz O.R.E. Subbottom Profiler. This system is a continuous seismic reflection profiler with the specialized capacity of high resolution of shallow stratified layers. Depth penetration to as much as 50 feet with a resolution on the order of 6 inches was obtained in certain areas of the Bay. The 3.5 KHz transducer was the system of primary interest since dredging of the Bay sediments normally does not exceed 40 feet below mean lower low water and the high resolution of the system was required for subsequent investigations.

A second system was used to provide intermediate penetration-resolution and back-up for the 3.5 KHz system in areas where the subbottom characteristics limited the penetration of that system. The E.G.&G. Uni-Boom (Unit Pulse Boomer) was used, being capable of penetrating Bay sediments to a depth of as much as 150 feet with a resolution as great as one foot. This system is also a continuous seismic reflection profiler and was run simultaneously with the 3.5 KHz system.

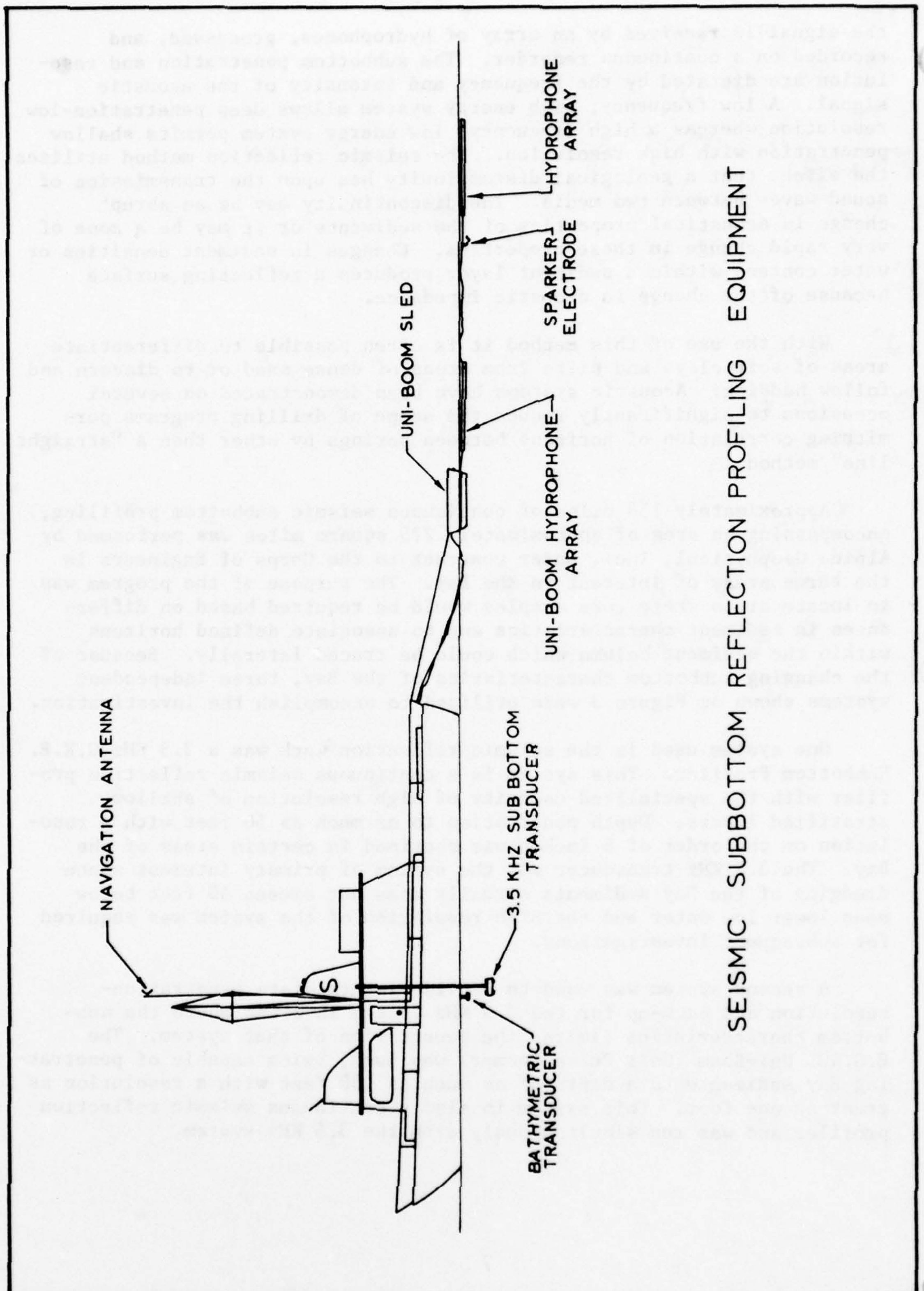

SEISMC SUBBOTTOM REFLECTION PROFILING EQUIPMENT
NAVIGATION ANTENNA
S
3.5 KHZ SUB BOTTOM
TRANSDUCER
BATHYMETRIC
TRANSDUCER
UNI-BOOM HYDROPHONE
ARRAY
UNI-BOOM SLED
SPARKER
ELECTRODE
HYDROPHONE
ARRAY

FIGURE 3

The third system used was a Sparker survey in which an electrical discharge (spark) in the water produces a high level, relatively broad-band impulse which is then reflected from the bottom and subbottom interfaces and received with a hydrophone array. This system is capable of penetrating Bay sediments to a depth of 300 feet, but with a resolution allowing interpretation of gross features only. Figures 4 and 5 are samples of the continuous profile records.

Horizontal control of the profiling track was accomplished using the Hydro-Plotter navigation system, a range-azimuth system with an accuracy of ten feet. The system consisted of a shore master station and a remote/slave station aboard the vessel. The shore station maintained a track of the vessel's position each minute and compensating navigation correction, when necessary to maintain track lines, were given to the vessel by the shore station.

Bathymetric control was obtained by means of a precision bathymetric recorder. The records were corrected to mean lower low water through the use of tide gages. The bathymetric recorder is accurate to less than 6 inches.

CORE SAMPLING AND ANALYSIS

The present method for pollution sampling of bottom sediments in San Francisco Bay by the Corps of Engineers is the push-tube vertical core method. The method allows fairly deep penetration into the unconsolidated sediments with the minimum amount of disturbance to the sediment in the core. A 4-inch pipe casing is used in which a 2-inch I.D. steel push-tube barrel is inserted. The pipe casing is lowered to the bottom from the surface vessel. The push-tube barrel armed with a 30-inch acrylic liner is then inserted into the pipe casing and pushed into the sediment to obtain a core sample. Each core sample is 30 inches in length. The pipe casing allows consecutive 30-inch samples to be taken in the same hole by wash-boring to the desired depth before the next increment is taken. The sediment is retained in the liner by creating a vacuum with a vacuum piston. After the core samples are brought aboard the vessel, a visual description is recorded including the strata thicknesses, composition, color and texture at various levels. The core samples are then frozen and delivered to the laboratory for analysis.

For this study an additional forty-eight cores were taken to depths up to -60 feet, MLLW. The core holes were selected on the basis of examination of the continuous seismic reflection profile lines in the three areas. All core holes were located on the seismic reflection profile track, enabling a comparison to be made of the boring logs and reflection profiles. The selection of holes and the depths to which the samples were taken were based on: (1) the subbottom reflection surfaces

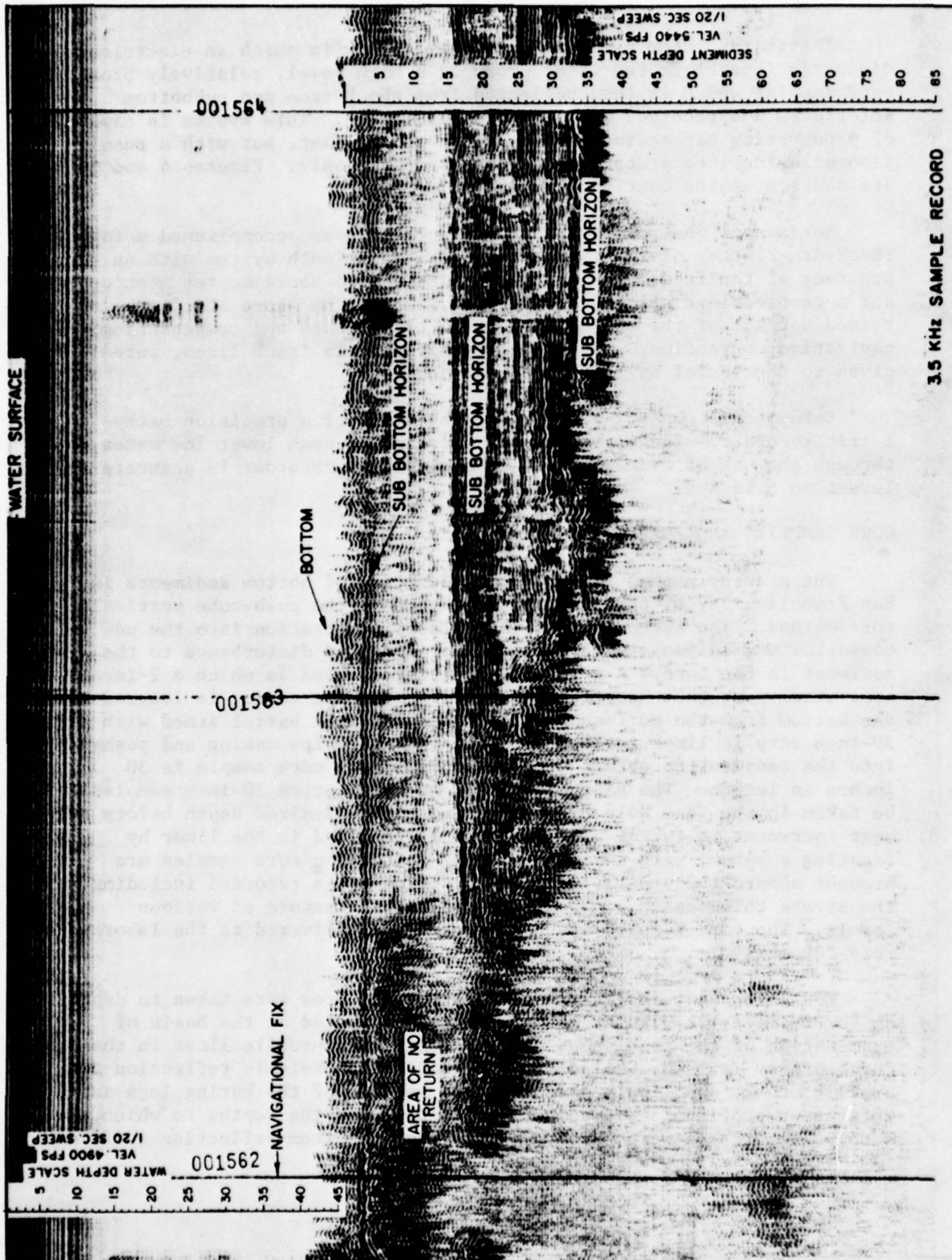
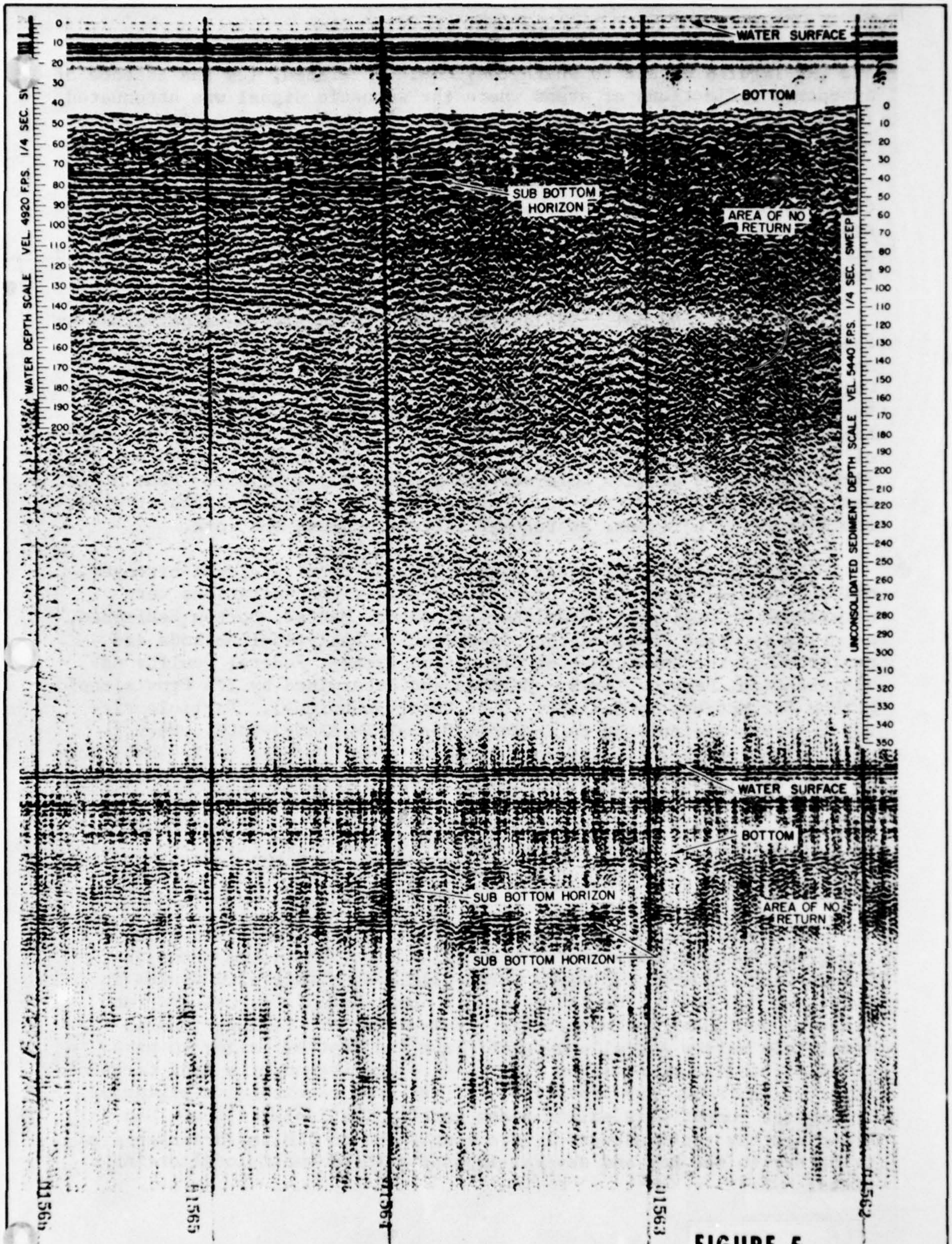

3.5 KHz SAMPLE RECORD
WATER SURFACE
BOTTOM
SUB BOTTOM HORIZON
SUB BOTTOM HORIZON
SUB BOTTOM HORIZON
AREA OF NO RETURN
NAVIGATIONAL FIX
001562
001563
001564
WATER DEPTH SCALE
VEL. 4900 FPS
1/20 SEC. SWEEP
SEDIMENT DEPTH SCALE
VEL. 5440 FPS
1/20 SEC. SWEEP

FIGURE 4



WATER SURFACE
BOTTOM
SUB BOTTOM HORIZON
AREA OF NO RETURN
WATER DEPTH SCALE VEL. 4920 F.P.S. 1/4 SEC. SWEEP
UNCONSOLIDATED SEDIMENT DEPTH SCALE VEL. 5440 F.P.S. 1/4 SEC. SWEEP
WATER SURFACE
BOTTOM
SUB BOTTOM HORIZON
AREA OF NO RETURN
SUB BOTTOM HORIZON
01566
01565
01564
01563
01562

FIGURE 5

and the lateral extent to which they could be traced, (2) the absence of subbottom reflections or areas where the acoustic signal was attenuated in the first few feet of subbottom, and (3) areas of known high contaminant concentrations or areas of prime interest such as dredged channels.

Position fixing of core holes was accomplished with the use of the Cubic Autotape navigation system, a microwave range - range positioning system with an accuracy of 6 feet. After location of the sampling site with the electronic navigation system a marker buoy was placed overboard for easy relocation by the sampling barge.

Mechanical and pollution analysis of core samples were performed by the Corps of Engineers South Pacific Division Laboratory, Sausalito. Core samples were split lengthwise and refrigerated upon delivery. Color photographs and a visual description were recorded for each core section including physical appearance, sedimentary stratification, texture, odor, and color. Sample selection was made from only one-half of the split core; the other half was stored for future reference. The first six inches of each hole was homogenized for analysis. Four other samples were selected from each core by horizons where visible or with the absence of horizons, at regular intervals along the core.

Volatile solids, chemical oxygen demand, total Kjeldahl nitrogen, oil and grease, lead, zinc, cadmium and copper concentrations were determined according to "Chemistry Laboratory Manual, Bottom Sediments," compiled by Great Lakes Region, Committee on Analytical Methods and published by the Environmental Protection Agency, Federal Quality Administration, December 1969. Mercury was determined by EPA Provisional Method for Mercury in Sediment (Cold Vapor Technique). Particle size was determined according to Engineer Manual EM 1110-2-1906. Visual classification of soils was in accordance with "Unified Soil Classification System," TM-357, Appendix A, April 1960. A total of 229 samples were analyzed.

PHYSICAL DESCRIPTION OF BAY

PHYSIOGRAPHY

San Francisco Bay is a drowned valley that passes the drainage of the great Central Basin of California. The outlet to the ocean is the Golden Gate - a one mile wide, three-mile long strait with depths in excess of 300 feet. The Bay system is comprised of several distinct areas separated by narrow straits. Suisun Bay at the upper end is moderately narrow and allows runoff from the Central Valley to pass quickly into the more saline areas west of the seven-mile long Carquinez Strait. San Pablo Bay provides the first area of extensive mixing of freshwater runoff with saline ocean water. The isolated South San Francisco Bay receives very little runoff due to limited drainage area tributary to the Bay and several impoundments of small local drainage areas.

The configuration of the Bay system allows a separation into three subsystems; Central San Francisco Bay, South San Francisco Bay and North San Francisco Bay (San Pablo Bay) shown on Figure 6.

The Bay System has an area of 396 square miles at mean lower low water and 460 square miles at mean higher high water. Extensive inter-tidal mudflats, encompassing an area of 64 square miles are exposed at lower low water. There remains 127 square miles of marshland along the perimeter of the Bay's 275-mile shoreline. The Bay is generally shallow with two-thirds of the area less than 18 feet deep and only 20 percent greater than 30 feet deep.

GEOGRAPHY

Current patterns and water surface elevations in the Bay system are determined by the effects of the configuration of the system on fresh-water and tidal inflows. Except in areas near the entrance to San Francisco Bay and narrow channels extending to the extremities, the entire Bay system is shallow, averaging about 15 feet of water depth. The submarine configuration formed by the series of broad shallow bays connected by narrow straits delays the progress of tide through the system because each successive bay must fill and empty the large volume of its tidal prism through its narrow opening, therefore delaying the arrival of the tide adjacent downcurrent bay. Tidal changes at Martinez on the south shore of Carquinez Strait, for example, lag those at the Golden Gate by 1.6 hours for high water and 2.2 hours for low water. The configuration of the system also affects the relative amplitude of the tides as well as tidal current velocities in various parts of the system.

The tidal lags and amplitude variations in the Bay system result in increased residence time of sediments in some parts of the system and decreased residence time in others, having the effect of increasing deposition in some areas and scour in others.

The physical geography of the Bay has been significantly modified by land reclamation work since the middle of the nineteenth century. The purpose of historical land reclamation has differed throughout the Bay and has resulted in a variety of land use patterns on new land recovered from the Bay. A direct effect of land reclamation on pollutant distribution has been alteration of the pre-1850 tidal hydraulic regimen causing modification of the estuary's ability to assimilate or disperse contaminants.

The surface area of San Francisco Bay (including marshlands) prior to 1850 is estimated to have been 787 square miles (Ref. 4). The pre-1850 Bay consisted mostly of a shallow, shelving Bay floor with extensive sub-tidal and inter-tidal flats coupled with expanses of salt marshland, situated mainly in South Bay, San Pablo Bay and Suisun Bay.

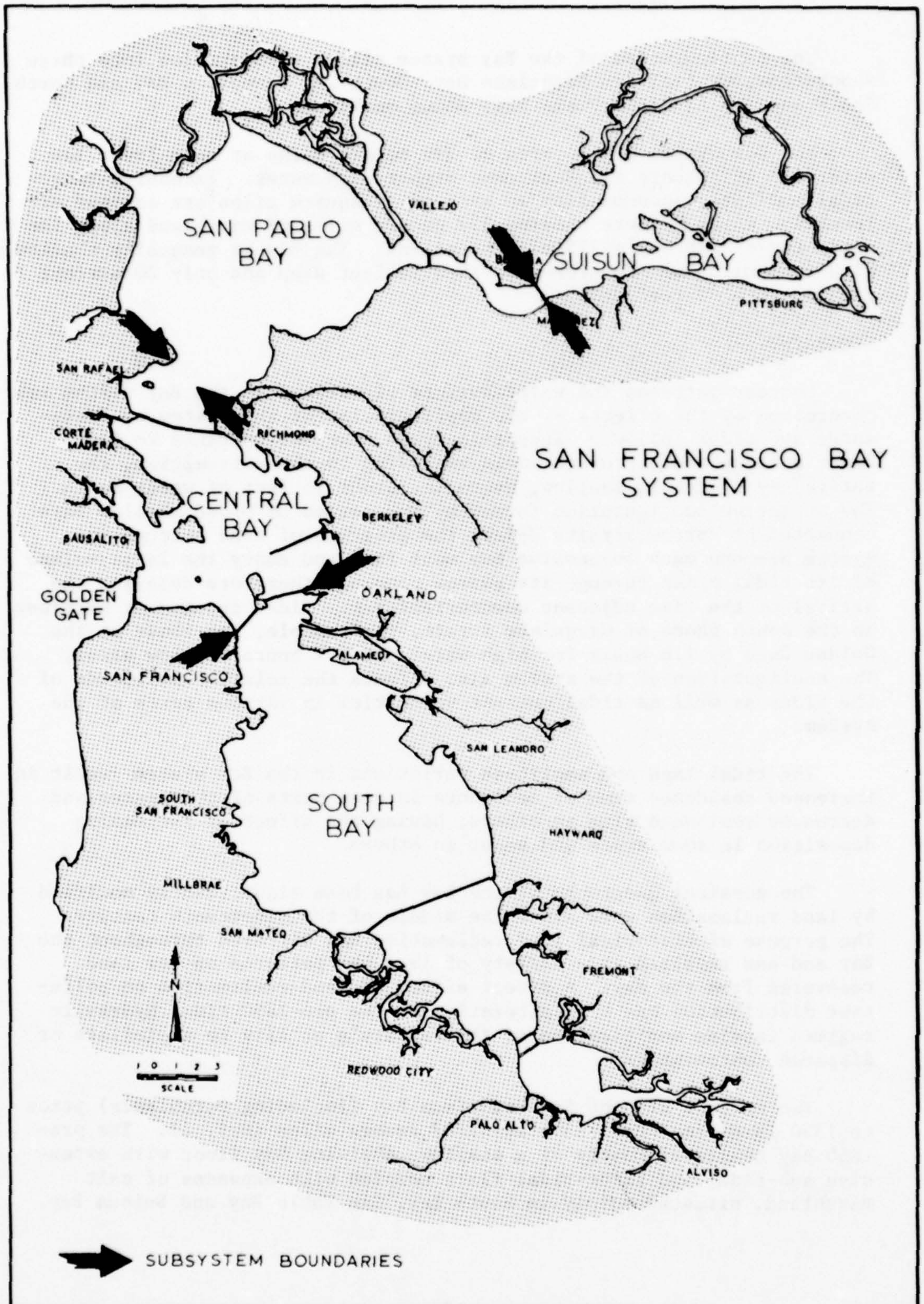

SAN PABLO BAY
VALLEJO
SUISUN BAY
PITTSBURG
SAN RAFAEL
RICHMOND
CORTE MADERA
SAN FRANCISCO BAY SYSTEM
CENTRAL BAY
BERKELEY
SAUSALITO
GOLDEN GATE
OAKLAND
SAN FRANCISCO
SAN LEANDRO
SOUTH SAN FRANCISCO
SOUTH BAY
HAYWARD
MILLBRAE
SAN MATEO
FREMONT
N
SCALE
REDWOOD CITY
PALO ALTO
ALVISO
SUBSYSTEM BOUNDARIES

FIGURE 6

Since the mid-nineteenth century, approximately 239 square miles or 31 percent of the Bay system has been either filled or diked-off and drained to provide new land for a range of activities.

Initial land reclamation along the shore of the Bay system was aimed at developing port facilities and maritime commerce adjacent to deep water in Central San Francisco Bay. Other early land reclamation operations were carried out to recover additional agricultural lands from salt marshlands situated mainly in South Bay, San Pablo Bay and Suisun Bay. Subsequent reclamation projects have recovered new land for salt ponds, as well as, industrial, transportation, residential and recreation uses.

The Corps of Engineers estimated the use of the 239 square miles of new lands to be as follows:

USE	% RECLAIMED LAND
Transportation	7.2
Industrial	4.8
Residential & Commercial	3.9
Military & Reserved Lands	6.3
Recreational	26.9
Salt Ponds	24.8
Agricultural	23.2
Dumps & Vacant Lands	2.9

Of the 239 square miles of reclaimed lands, approximately 40 percent are situated in Central and South San Francisco Bay, 30 percent in San Pablo Bay, and 30 percent in Suisun Bay. The largest portion of this new land (93%) has been recovered from marshlands while the remaining 7 percent has been recovered from inter-tidal and sub-tidal lands (Ref. 5).

Reclamation has irrevocably changed the geometry of the Bay by reducing both the volume and surface area of Bay waters. The tidal prism has been diminished (Ref. 5), causing a general reduction of tidal current velocities, and, to a lesser extent, reduction of tidal elevations and ranges, combined with alteration of salinity in different parts of the estuary (Ref. 4). This reduction of the tidal prism has diminished the ability of tidal currents to disperse and flush contaminants out of the Bay system. Land reclamation has reduced the surface area of the Bay by eliminating fringing tidal flats and marshlands. This has diminished the system's ability to reoxygenate its waters. Lowering the dissolved oxygen content of the Bay has reduced the capacity of the estuary to aerobically decompose biodegradable contaminants.

Alteration of the submarine configuration of the Bay basin coupled with the reduced tidal prism has increased shoaling rates and changed sedimentation patterns in many areas. The accelerated shoaling rate is caused by reduced tidal current velocities, increased salinity (and therefore, flocculation), and decreased Bay volume. Surface areas and volumes have been reduced mainly around the shallow perimeter of the Bay.

GEOMORPHOLOGY

The recent landscape evolution which created San Francisco Bay has been complicated and is not clearly understood. Some general facts are known. The valley that became the Bay was a structural deformation trough formed by tetonic downwarping and faulting during the Pliocene Epoch (Ref. 6). Subsequent structure deformations caused by crustal compression took place in the Pleistocene. The basic outline of the bay-valley as it appears today was shaped by this point in time. This valley form has been continually modified by local processes of erosion and deposition.

The river system, which became the Sacramento-San Joaquin, developed an outlet in the vicinity of the Golden Gate prior to the Pleistocene. This river system, which drains the great Central Basin of California was well established in this epoch. During the Pleistocene the north-south trending hills surrounding the bay-valley were uplifted at a rate slow enough to allow the river to maintain its course to the sea and to carve deep canyons at Carquinez and at the Golden Gate.

San Francisco Bay was formed by flooding of the valley during the interglacial stages of the Pleistocene and Holocene (Recent). The most recent marine transgression occurred 15,000 to 25,000 years ago with the advent of the Wisconsin interglacial stage. These fluctuating invasions of the sea into the bay-valley were, mainly, a result of eustatic rise in sea level caused by melting of massive continental glaciers and local subsidence. The rise in sea level is estimated to have been about 300 feet (Refs. 7 and 8). Local subsidence has also been a factor in the change of sea level in the Bay. Archaeological evidence derived from shell mound excavations on the east shore of the Bay indicated sea level has risen 25-30 feet in the last 3,500 years.

PHYSICAL ESTUARINE PROCESSES

Contaminants enter the San Francisco Bay system through natural weathering processes of rocks and soils and by anthropogenic means on land, air and water. The estuary is a sink or settling basin for all upstream discharges or discharges directly into the estuary. Contaminant concentrations depend on the estuary's ability to assimilate or disperse the contaminants. The estuary is a complex system of interacting forces such as winds, currents and tides, and physical factors such as geography which dictate the distribution of contaminants.

The distribution of pollutants depends on energy gradients - contaminants move from zones of higher energy to zones of lower energy within the Bay system. Tides, waves, and currents are the physical agents most responsible for eroding, transporting, and depositing sediments within the San Francisco Bay system. The types, characteristics, and effects of tidal regimen, waves, and tidal and non-tidal currents on determining circulation patterns and distribution of contaminants are described in this section. The influence of other physical factors such as wind, atmospheric pressure, freshwater inflow, salinity and hydrology on tides, waves and currents are also evaluated.

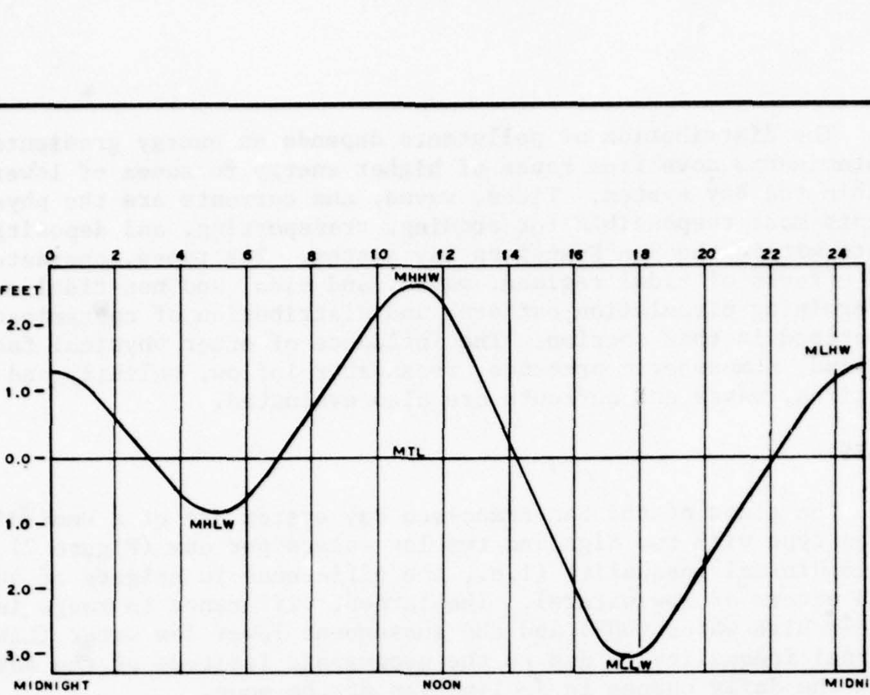
TIDES

The tides of the San Francisco Bay system are of a semi-diurnal mixed type with two high and two low waters per day (Figure 7) with a large diurnal inequality (i.e., the difference in heights of successive high waters or low waters). The largest difference in range is between higher high water (HHW) and the subsequent lower low water (LLW). This diurnal inequality is due to the geographic latitude of the Bay coupled with the daily change in declination of the moon.

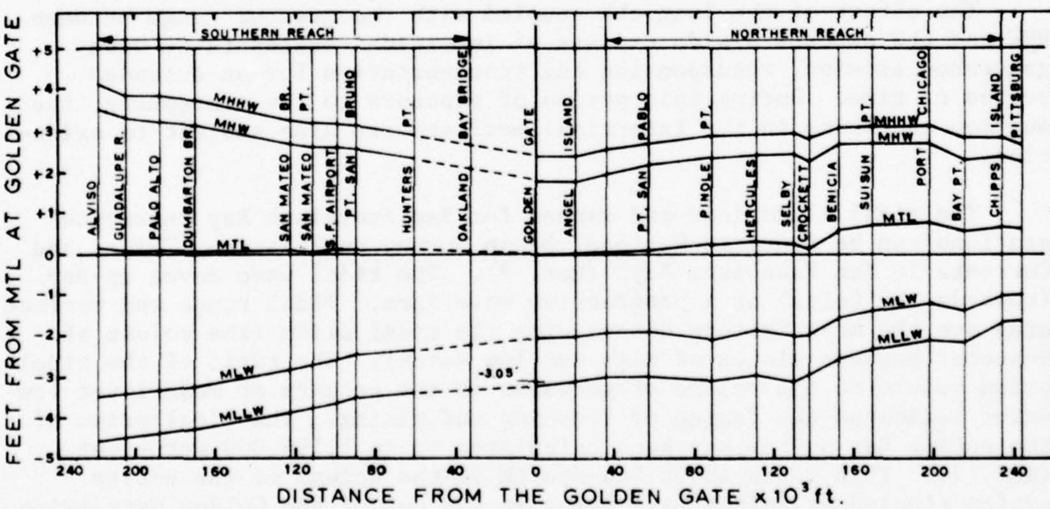
The submarine geometry and hydraulics of the Bay system attenuate this tidal wave resulting in a time lag difference in the arrival of the crest or trough of the tidal wave at various locations in the Bay. The rise and fall of the tide modifies the effect of wave action on the bottom sediments (i.e., shallow sub-tidal zones of the Bay are exposed to greater wave turbulance during periods of low water than high water).

The effect of the long ebb coupled with the greater range between HHW and LLW exposes a wide expanse of intertidal sediments to wave generated erosion, resuspension and transportation for an extended period of time. During this period of exposure to the atmosphere, the surface sediments in the intertidal mudflats are also subject to oxidation.

The tidal elevations and ranges for San Francisco Bay reference stations can be found in National Ocean Survey publication, "Tides and Currents in San Francisco Bay" (Ref. 9). The tidal wave moves up-Bay (towards the Delta) as a progressive wave form. Tidal range and surface area are the main factors determining the tidal prism (the volume of seawater between planes of high and low water). The ratio of the tidal prism volume to the volume of seawater in the estuary at mean lower low water indicates the degree of flushing and mixing. The tidal prism of the entire Bay system has been calculated to be 1,196,000 acre-feet (Ref. 3). This means about one-fourth of the volume of the entire system (including Suisun Bay) moves in and out of the Golden Gate twice during each tidal day.



MEAN TIDE CURVE AT GOLDEN GATE
SAN FRANCISCO BAY



ELEVATION OF MEAN ANNUAL TIDAL STAGES

FIGURE 7

WAVES

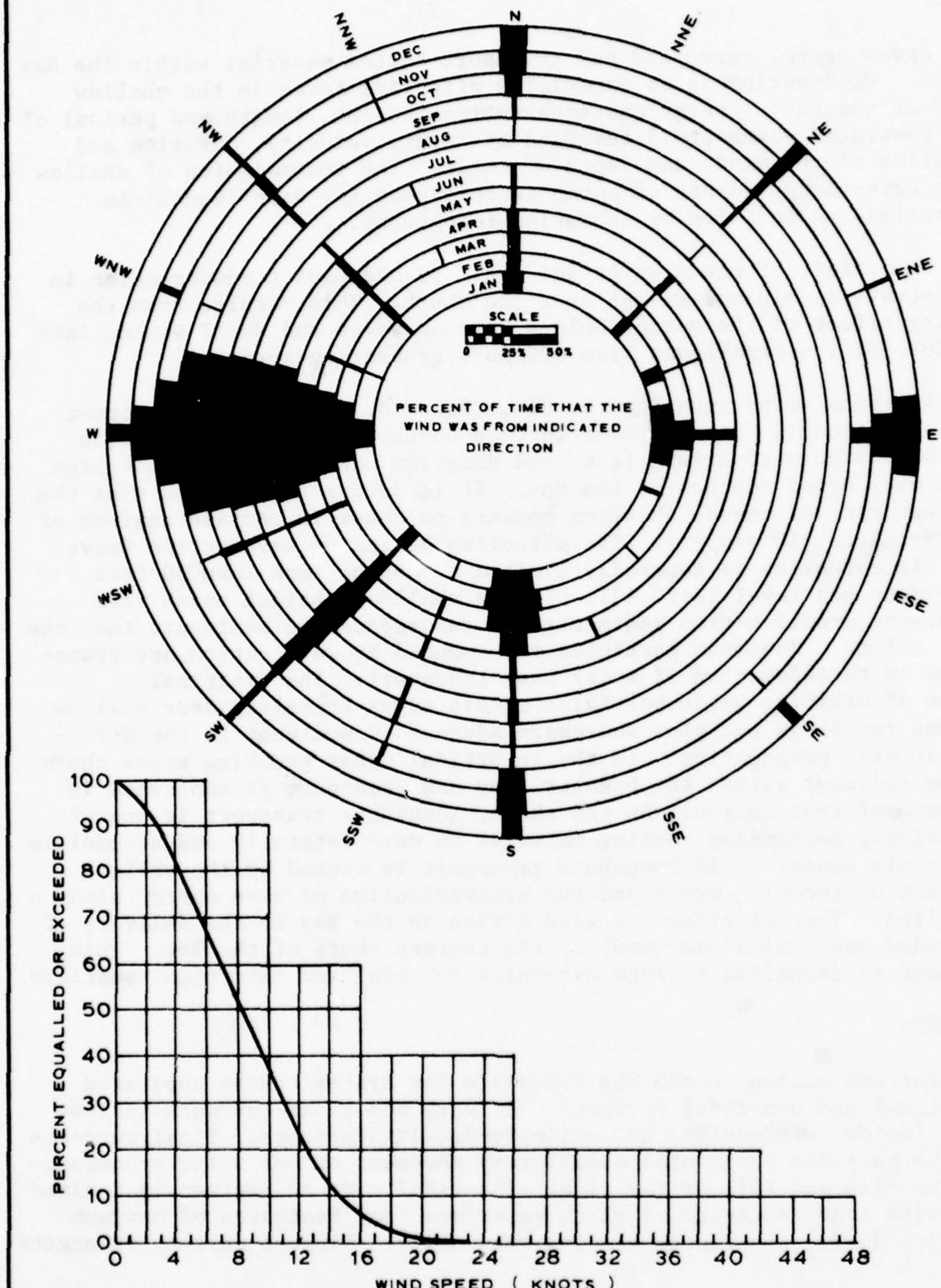
Waves erode, resuspend and transport bottom material within the Bay system. Wave action is an especially effective force in the shallow areas of the Bay. Energy characteristics (height, length and period) of wind generated waves are determined by fetch, velocity, duration and direction of the wind, and depth of water. The transmission of shallow water wave energy (depth of water is less than 1/2 wave length) is controlled and modified by submarine topography.

The effect of ocean waves and swell on sediment transportation in the estuary is minimal except near the mouth. This results from the damping effect of the narrow Golden Gate on waves and swell moving into the Gulf of the Farallones from offshore generating areas.

A typical wind rose for the Bay, Figure 8, shows the predominant wind direction is from the west through south. These wave producing forces coupled with a long fetch and duration can generate 3-foot high waves over broad reaches of the Bay. It is during this period that the greatest rate of annual shoaling appears to occur in certain regions of the Bay (Refs. 10 and 11). The effective depths of wave action (wave base) in estuaries is generally limited to depths less than 30 feet below mean sea level (Ref. 12). In the shallow subtidal areas wave turbulence erodes bottom sediments and resuspends the sediments into the water column. Sediment particles resuspended by wave action are transported in the direction of water mass transport. The progressive motion of orbiting water particles within waves traveling over shallow regions result in the slow shoreward advance of sediment in the direction of wave propagation. In the intertidal areas breaking waves churn up the sediment within the breaker zone and transport it shoreward in the wave of translation. At the shore, longshore transport is one of the primary mechanisms causing material to move laterally and accumulate in certain zones. This longshore transport is caused by the oblique approach of incoming waves and the redistribution of wave energy along a shoreline. The net effect of wave action in the Bay is the delivery of suspended and bedload sediment to the eastern shore of the Bay. This sediment is deposited to form extensive subtidal and intertidal mudflats.

CURRENTS

Current action in the San Francisco Bay system can be separated into tidal and non-tidal currents. Primary non-tidal currents include river inflow, wind-drift, and salinity-density currents. Tidal currents are the periodic horizontal oscillatory movement of sea water accompanying the rise and fall of the tide. The tidal current regimen is a mixed type with four instances of slack water and four instances of maximum velocity during two floods and two ebbs daily. Highest current strengths



WIND OBSERVATIONS FOR DAVIS POINT, 1974

SOURCE: NOAA, NATIONAL WEATHER SERVICE SFO WSFO

FIGURE 8

are attained during the period of long ebb between higher high water and lower low water of the tidal cycle. Ebb currents are increased by freshwater outflow, conversely flood currents are reduced by the same force.

Submarine topography and hydraulics of the Bay system cause differences in time (phasing) of maximum current velocities and direction at different sites. A lag occurs between time of high water and low water, and time of maximum flood and ebb.

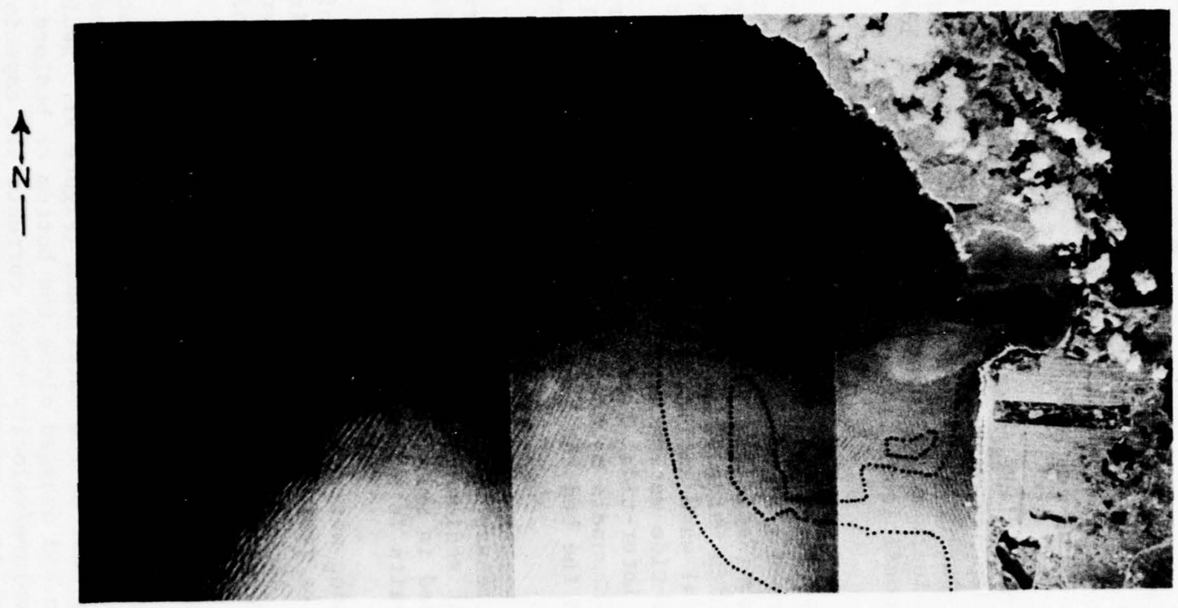
Velocity and direction of tidal currents vary in the water column with depth, and direction depends on phasing of tide, freshwater inflow and submarine topography. During high freshwater inflow (winter conditions), ebb currents predominate at all depths. However, during low freshwater inflow (summer conditions) flood currents predominate at lower depths (Ref. 11).

The residual component of coastal tide causes the amount of water carried by the flood to exceed that of the ebb. This characteristic is counteracted by river inflow (Ref. 13). There is a longer period of low current velocities around high water slack than during low water slack caused by a decrease in tidal wave amplitude towards the tidal flats along the Bay shore. Flood-tide waters advance in a uniform front, depositing material on the inter-tidal flats as they travel shoreward. Ebb tide waters retreat in channels meandering across the intertidal flats eroding material from the bed and banks of the channels as they move towards deeper water.

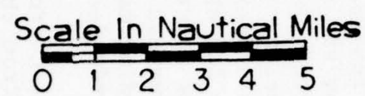
Tidal currents erode, resuspend (turbulent mixing) and transport sediment from the up-current sediment reservoirs of Suisun and San Pablo Bays. This sediment is moved in suspension and as bedload through Carquinez and San Pablo Straits into Central San Francisco Bay.

Once these sediment laden waters arrive in the broad expanses of Central Bay their velocity is diminished, and they lose much of their ability to carry sediment. At the same time these brackish waters are mixed with more saline ocean waters, and suspended sediments floc and settle to the bottom. These newly arrived sediments are subject to movement by additional estuarine processes.

Freshwater inflow during winter storm runoff transports sediment through North and Central Bays and the Golden Gate dispersing the sediment charged waters into the Gulf of the Farallones (Figure 9). Sediment is transported in suspension and dragged along the bottom as bedload. During the wet season high volume/velocity river currents are especially effective in eroding, resuspending and flushing unconsolidated sediments from the Bay floor. Sediment temporarily settles during calms between winter storms.



PHOTOGRAPH -THREE FRAMES FROM NASA EARTH RESOURCES AIRCRAFT PROJECT, MISSION 123, SITE 211, 10 MARCH 1970, 50,000 FEET, FALSE COLOR INFRARED, YELLOW FILTER.



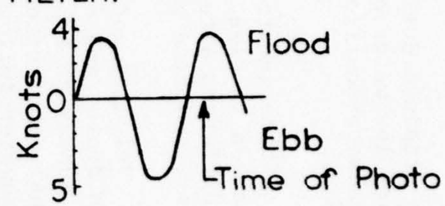


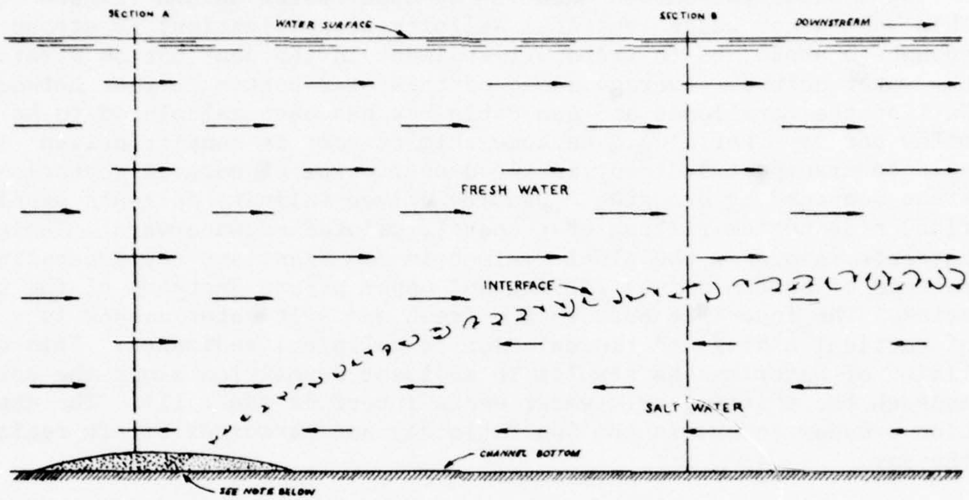
FIGURE 9

Freshwater inflow dilutes and mixes with saline water in the Bay. This results in horizontal and vertical salinity gradients. These gradients are greatest during winter freshets. Density-salinity currents move up-Bay along the Bay floor displacing less saline waters moving towards the Golden Gate in the upper water column (Figure 10). This salt-water wedge (vertical salinity stratification) is strong enough to erode and to transport sediment in the near bottom strata of the water column. Average speed of this near bottom current between the Gulf of the Farallones and San Pablo Bay has been calculated to be 2.5 miles per day (Ref. 14). Because this current is density driven, it is able to transport sediment in the deeper parts of natural channels and areas deepened by dredging. Density driven salinity currents supplement flood tide bottom filling of tranquil, maintained waterways. These currents reinforce the tidal regimen in San Francisco Bay generating a pattern of bottom strata filling and upper strata emptying of the tidal prism. The interface between the fresh and salt water masses is a zone of vertical mixing and flocculation of colloidal sediments. This collision of water masses results in sediment deposition along the bottom beneath the shifting salt water wedge interface (Ref. 11). The deposition process occurs in the San Pablo Bay and Carquinez Strait region of the Bay.

The prevailing wind forces over the Bay produce two distinct wind-drift currents. Velocities of wind-drift currents in estuaries reach 2-5 percent of the wind force (Ref. 15). Strong westerly summer winds produce easterly setting currents. These currents drive sediment bearing surface waters across the open water reaches of the Bay and piles water up along the shore (wind set-up). Winter winds blow predominately from north-northeast which increase the competency of freshet and tidal flows to flush out unconsolidated sediments from North and Central Bays. This offshore wind pattern is frequently interrupted by violent southeast gales associated with low pressure systems passing west to east over the Bay area. Southeasterly winter gales are generally of short duration and generate very temporary north setting currents.

Other factors affecting sediment resuspension patterns are vessel movement, coriolis force and shoreline structures. Sediments resuspended by vessel passage and associated prop wash are susceptible to movement by currents. Coriolis force concentrates current flows to the right of their setting direction in the northern hemisphere. Hence, flood tide tends to flow on the east shore and ebbtide tends to flow on the west shores of the Bay. In the confined area of the Bay the effect of this force is not great. However, it still reinforces disposition of sediments. Manmade shoreline structures (e.g., piers, wharves, groins, and other structures), as well as, indentures along the shore create eddies and entrap sediments.

FIGURE a. CONDITIONS TYPICAL OF HIGHLY STRATIFIED ESTUARY

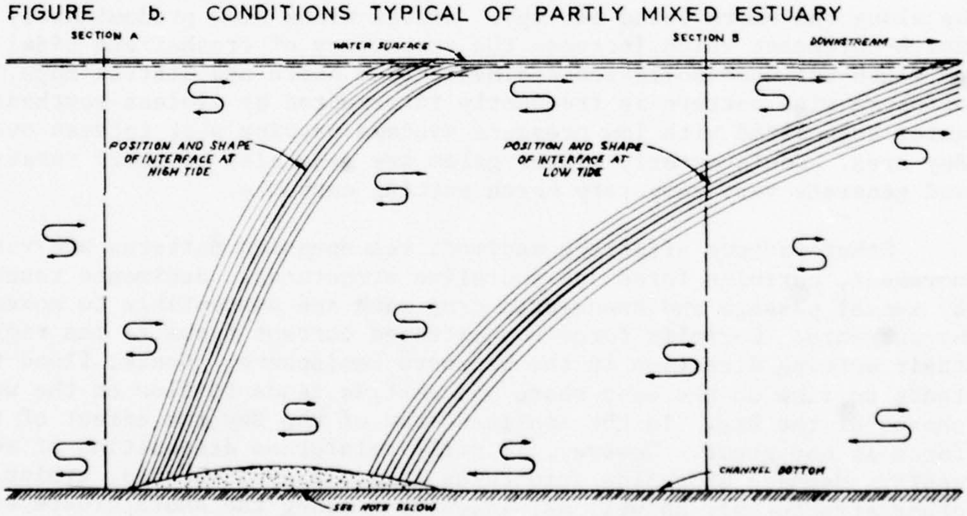


Indicates constant downstream flow

Indicates constant upstream flow

NOTE: Rapid shoaling occurs in this region heavy particles deposit just upstream from wedge tip and lighter particles just downstream from tip

FIGURE b. CONDITIONS TYPICAL OF PARTLY MIXED ESTUARY



Indicates that direction of current reverses with tidal phase, but that predominant current is downstream

Indicates that direction of current reverses with tidal phase, but that predominant current is upstream

Indicates that direction of current reverses with tidal phase, but there is no predominant current

NOTE: Rapid deposition of both heavy and light particles of sediment usually occurs in this region

FIGURE 10

BAY SEDIMENTS

Geologic formations in and adjacent to San Francisco Bay are principally alluvial formations ranging in age from mid-Pleistocene to Recent. Sediments deposited within the Bay are very soft to firm clay with varying amounts of silt, sand, and carbonaceous material. Bay sediments have been classified as Older Bay Mud Formation, Sand Deposits and Younger Bay Mud Formation.

OLDER BAY MUD FORMATION

The Older Bay Mud Formation includes formations such as Alameda, San Antonio, Posey, and in some instances Temescal formations. Older Bay Mud is composed of firm clay with varying amounts of silt, sandy clay, sand and small gravel. The sand is usually lenticularly bedded and contains shell layers. The formation is from 0-200 feet thick and has been preconsolidated to a degree greater than would result from the weight of overlying sediments. The wet weight of the sediment is greater than 90-110 pounds per cubic foot and is less than forty percent moisture. The minus two micron particles are fifty percent normal and hydrated mica, plus montmorillinite, chlorite, diatoms, carbonaceous material, quartz and feldspar. The upper part of the formation interfingers with sand layers.

SAND DEPOSITS

Sand deposits consist of local areas within the Bay containing fine-grained sand that grade into sandy silt and sandy clay. The Sand Deposits may or may not be covered with Younger Bay Mud. The Sand Deposits are not a continuous blanket, but are scattered as if each lense represents a small alluvial fan, indicating a fluctuating shoreline.

YOUNGER BAY MUD FORMATION

The Younger Bay Mud Formation overlies the Older Bay Mud and Sand Deposits. This formation can be divided into a Semi-Consolidated Bay Mud member and a Soft Bay Mud member. The Soft Bay Mud member varies in thickness from 40-70 feet and is described as a soft mud that becomes firmer with depth. With increasing depth there is a sudden increase in the strength and pre-consolidation load as if the material below this level was pre-consolidated to a degree greater than would result from the weight of the overlying mud. The Bay Mud below this level is termed Semi-consolidated and is similar to the Soft Bay Mud member but pre-consolidated to a degree greater than would result from the weight of overlying material. There is a noticeable increase in strength above a dry unit weight of 60 pounds per cubic foot and a decrease in moisture to near forty percent. The Soft Bay Mud member is composed of clayey, plastic, low strength materials. It can be described as a soft, plastic, black-to-gray silty clay, clayey silt with minor organic

material and clayey fine-grained sand. The net weight is less than 90-110 pounds per cubic foot and more than forty percent moisture. The clay size particles make up from 45-90 percent of the material, and peaty or lignitic material is five percent. The clay size fraction is composed of one-third montmorillinite, one-third normal and hydrated mica, and one-third mixed-layered montmorillinite, chloritic and kaolinitic materials.

The character of the Bay Muds suggests that the Older Bay Mud formation was deposited in the interglacial epoch immediately preceding the formation of the Wisconsin ice sheet. Pre-consolidation of the Older Bay Mud formation occurred during the first glacial advance of the Wisconsin ice. The semi-consolidated member of the Younger Bay Mud formation was deposited during the first Wisconsin interglacial epoch and was desiccated during the second advance on the Wisconsin ice. The Soft Bay Mud member has been forming since the retreat of the Wisconsin ice.

SEDIMENTATION IN THE BAY

Sediment deposition in the Bay system depends on local circulation conditions, type of accumulation process, physical characteristics of sediment particles, as well as, concentration and availability of suspended and bedload material. Sediment deposition patterns reflect the energy gradient formed by dynamic estuarine forces within the Bay. Suspended and bedload material is transported from high energy areas to low energy areas. Suspended and bedload concentration is directly proportional to transportation energy, if the available sediment supply is not a limiting factor. Wave action and current velocity are the dynamic mechanisms controlling sediment transportation. Therefore deposition zones are situated in tranquil areas where the energy of these forces is dissipated or nonexistent. Suspended sediment settles to the Bay floor as a result of gravity force in these quiescent accumulation zones.

It has been shown that on submerged tidal flats wave action predominates over current velocity as a distributary force (Ref. 16). Horizontal variation in sediment grain size characteristics across the surface of the submerged flats correlates directly with wave energy distribution. Wave action over submerged flats is determined by the force of waves arriving from adjacent deepwater/channel areas and waves generated over the flats themselves. Waves arriving from adjacent deep water channel areas gradually lose power as they enter and move across shallow areas resulting in decreased grain size and increased deposition downwind and away from the deepwater/ channel areas. Waves generated over the submerged flats proper produce greater turbulence in shallow water over the flats resulting in a relative increase in grain size and decrease in sediment deposition rate.

In the deep water channel areas of the Bay currents are the predominate estuarine force. Current forces reach maximum velocities along the central portion of channels and diminish towards the channel margins. This energy gradient is reflected in the decrease in sediment grain size away from the axis of the channel. These channels are scour areas showing net erosion or are self-maintaining, having reached a temporary equilibrium state. The areas showing the highest sediment deposition rates in San Francisco Bay are the channel margin zones. These accumulation zones are too deep to be affected by wave action and too far away from the channel axis to be affected by strong current velocities.

Sediment inflow-outflow and distribution volumes within the San Francisco Bay system have been estimated by Gilbert of U.S.G.S. in 1917 (Ref. 16), Grimm of the Corps of Engineers in 1930 (Ref. 17), the Soil Conservation Service of the U.S. Department of Agriculture in 1947, the Corps of Engineers in 1954 and 1967 (Refs. 3 and 18), State of California Department of Water Resources in 1955, Porterfield, Hawley and Dunnam of the U.S.G.S. in 1961 (Ref. 19), Smith of the Corps of Engineers in 1963 (Ref. 20), and Krone in 1966 (Ref. 19). These studies have led to a large variance in inflow-outflow and distribution volumes in the Bay system. The variance can be attributed to paucity of data available to investigators at the time of each study.

Smith, using U.S.C. & G.S. surveys of the Bay at periodic intervals between 1855 and 1956 and logs of borings, estimated the total deposit of Bay sediments to be 16 billion cubic yards. The deposits were lightest in Suisun Bay, heaviest in Central Bay and roughly equal for the remaining areas. The ratio of deposition per acre is respectively, 1:3:2 for Suisun Bay: Central Bay and Carquinez Strait: San Pablo Bay and South Bay. Generally, these areas have experienced cycles of deposition and erosion, with the greatest deposition taking place during the hydraulic mining era in the Sierra Nevadas. Gilbert estimated that just during the period of 1850-1914 one and one-half billion cubic yards of sediment were deposited in the Bay system.

Estimated annual inflow volumes before 1961 reflect the limited amount of data available at the time. These volumes range from 8.0 million cubic yards predicted by Gilbert to 1.97 million cubic yards estimated by the Corps of Engineers in 1954. The U.S.G.S. in 1961 were the first to use direct measurements of suspended loads being transported into the Bay system by all sources. From these measurements the U.S.G.S. calculated the annual sediment inflow to the Bay system between the years 1957-1959 to be 8.8 million cubic yards. From this value they estimated the present annual inflow volume to be 8.0 million cubic yards. Smith in 1963 estimated that 8.33 million cubic yards per annum was the inflow rate to the Bay system. He derived his estimate from tonnages and daily sediment inflows by geographical areas for the years 1909-1959 and adjusted to 1957-1959 conditions. Smith considered these

volumes valid for the period 1960-2011. The Corps of Engineers in 1967 used the basic data developed by U.S.G.S. for the period 1957-1959 to arrive at the average annual sediment inflow value of 9.56 million cubic yards. The difference in the Corps 1967 value and U.S.G.S. 1961 value reflect different in-place density values used to convert weight of sediment to volume of shoal. Krone in 1966 estimated the average annual sediment inflows for the Bay system to be 10.5 million cubic yards, based on hydrologic data from 1922-1933 and U.S.G.S. measurements of suspended sediment for the years 1957-1965.

Of the sediment entering the Bay system from natural sources (new fluvial sediments) or from open water dredge disposal practices, a portion is conveyed to the ocean via the Golden Gate and a portion is retained in the Bay system. The Corps of Engineers in 1967 used two methods for determining sediment outflow. The first method, "Historical Shoaling Method," estimated the volume of sediment leaving the Bay as the difference between the sum of the new sediment inflow (10.0 million cubic yards) and dredge material released in the Bay (9.6 million cubic yards) and the sum of shoaling within and outside navigation channels and facilities (15.4 million cubic yards). The estimated average annual sediment outflow volume derived from the "Historical Shoaling Method" was 4.2 million cubic yards. The second method, "River Discharge Method," used an estimate of the net water discharge through the Golden Gate and an assumed average turbidity for Bay water. The product of turbidity and net water discharge gave the net sediment outflow. Analysis of numerous suspended sediment samples throughout the Bay system for conditions of low, average and flood flows indicated that the average turbidity in Carquinez Strait and easterly San Pablo Bay was about 70-80 parts per million, and at Golden Gate, about 40-50 parts per million. Assuming a turbidity of 50 parts per million for an average monthly discharge of 29,000 cubic feet per second, the Corps of Engineers using the "River Discharge Method," estimated the average annual outflow to be 3.3 million cubic yards. In addition, model studies indicated that an additional 1.4 million cubic yards would leave the Bay annually from open water dredge disposal practices, totaling 4.7 million cubic yards.

The Corps of Engineers in 1967 studied the historical sedimentation patterns in the Bay system using hydrographic surveys for a 101-year period from 1855 to 1956. The results of the study showed that there was an average annual net deposition of 5.2 million cubic yards.

Krone in his sedimentation studies of San Francisco Bay in 1966 and 1974 (Ref. 22) estimated that 8.1 million cubic yards of sediment annually leaves the Bay, while 2.4 million cubic yards are retained. Krone based his estimate on a steady state situation which he believes was reached in the Bay-Delta system in about 1957.

The State of California Department of Water Resources estimated annual net deposition in the Bay to be 2.1 million cubic yards. Table 1 is a composite of average annual inflow-outflow and deposition volumes from the above investigations.

Two other factors affecting the annual sedimentation in the Bay system are annual dredging and disposal operations and resuspension of bottom sediments due to wind generated turbulence and tidal currents. Approximately 10 million cubic yards of Bay sediment are dredged annually by the Federal Government and private concerns in the Bay system. The majority of this material is released in Bay waters at one of three disposal sites. Assuming that these sites received dredged sediments over a 250-day period and that the material disperses over a 100-square-mile area, 400 cubic yards of dredge material would be placed in suspension per square mile per day of dredging. In contrast, Krone estimated the amount of material suspended by wave action in a square mile of shallow area by conservatively using an average suspended sediment concentration of .5 grams per liter over a five-foot water depth when the wind blows over 10 knots. Using the value of 220 days per year when the wind velocity is 10 knots or greater, Krone estimated that each square mile of shallow area suspends 2,200 tons of sediments per day. Using the value of 25 pounds per cubic foot for sediments brought into suspension by wind and wave forces, the 2,200 tons may be converted to cubic yards, giving a total of 6,500 cubic yards per square mile per day as the volume of sediment resuspended by wind driven waves. Figure 11 is a summary of sedimentation in the San Francisco Bay system.

TABLE 1

ANNUAL SEDIMENT INFLOW-OUTFLOW AND DEPOSITION VOLUMES FOR SAN FRANCISCO BAY SYSTEM

Investigator	Inflow Delta	Inflow From Other Tributaries	Total Inflow	Sediment Outflow	Sediment Deposition
	(Millions of Cubic Yards)				
Gilbert (1917) predicted					
Prior to 1850	2.0				
1850-1914	23.0				
Present	8.0				
Grimm (1931)	5.75				-5.4*
Corps of Engineers (1954)					
Existing	3.36				
Future w/controls	1.97				
DWR (1955)					
Existing	4.0				
Future w/controls	3.0				
U.S.G.S. (1961)					
From 1957-1959	7.2	1.6	8.8		
Present	6.9	1.1	8.0		
Smith (1963)	7.04	1.195	8.235		5.2
Corps of Engineers (1965)	8.13	1.43	9.56	4.2	5.2
Krone (1966)					
By year 1960	8.1	2.4	10.5	8.1	2.4
By year 1990	4.3+	2.4	6.7		
By year 2020	3.0+	2.4	5.4		

* Considers only North Bay.

\+ Based on Delta Water Diversions.

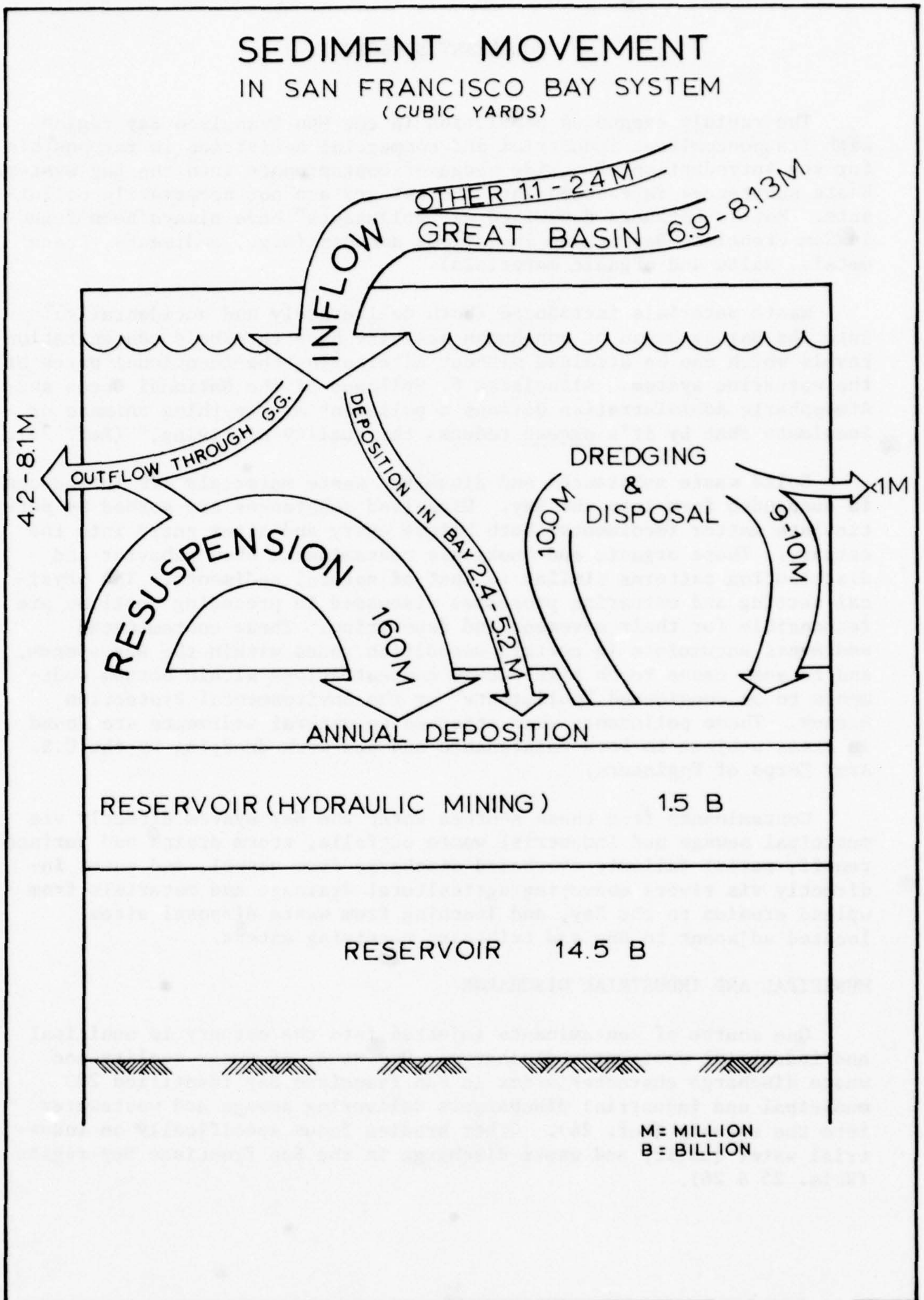

SEDIMENT MOVEMENT
IN SAN FRANCISCO BAY SYSTEM
(CUBIC YARDS)
OTHER 1.1 - 2.4M
GREAT BASIN 6.9 - 8.13M
INFLOW
OUTFLOW THROUGH G.G.
4.2 - 8.1M
DEPOSITION IN BAY 2.4 - 5.2 M
DREDGING & DISPOSAL
1M
10.0M
6-10M
RESUSPENSION
160M
ANNUAL DEPOSITION
RESERVOIR (HYDRAULIC MINING) 1.5 B
RESERVOIR 14.5 B
M= MILLION
B= BILLION

FIGURE 11

POLLUTANT SOURCES

The rapidly expanding population in the San Francisco Bay region with its concomitant industrial and commercial activities is responsible for the introduction of a wide range of contaminants into the Bay system. Waste substances introduced into the estuary are not necessarily pollutants. Most substances described as "pollutants" have always been found in San Francisco Bay system in various amounts (e.g., sediments, trace metals, salts and organic materials).

Waste materials introduced (both deliberately and accidentally) into the Bay by human or non-human activity have threshold concentration levels which can be attained without alternating the functional parts of the estuarine system. Althelstan F. Spilhaus of the National Ocean and Atmospheric Administration defines a pollutant as "anything animate or inanimate that by it's <u>excess</u> reduces the quality of living," (Ref. 23).

Solid waste substances and dissolved waste materials are introduced in suspended form into the Bay. Dissolved substances are sorbed by particulate matter (sediments) both before entry and after entry into the estuary. These organic and inorganic contaminants show behavior and distribution patterns similar to that of natural sediments. The physical setting and estuarine processes discussed in preceding sections are responsible for their movement and deposition. These contaminated sediments accumulate in certain deposition zones within the Bay system, and in some cases reach high enough concentrations within bottom sediments to be considered "pollutants" by the Environmental Protection Agency. These pollutants when attached to natural sediments are found in areas subject to both maintenance and new-work dredging by the U.S. Army Corps of Engineers.

Contaminants from these sources enter the Bay system directly via municipal sewage and industrial waste outfalls, storm drains and surface runoff, aerial fallout, overboard discharge from vessel, and enter indirectly via rivers conveying agricultural drainage and materials from upland erosion to the Bay, and leaching from waste disposal sites located adjacent to Bay and tributary receiving waters.

MUNICIPAL AND INDUSTRIAL DISCHARGE

One source of contaminants injected into the estuary is municipal and industrial wastewater discharge. One study of water quality and waste discharge characteristics in San Francisco Bay identified 203 municipal and industrial dischargers delivering sewage and wastewater into the estuary (Ref. 24). Other studies focus specifically on industrial water quality and waste discharge in the San Francisco Bay region (Refs. 25 & 26).

Of the 203 dischargers, 83 major ones are shown in Figure 12 (Ref. 27). This number does not include municipal and industrial dischargers injecting wastewater into the Sacramento-San Joaquin River system. There are 160 municipalities and sanitary districts and 6,000 manufacturing enterprises located within the San Francisco Bay and Sacramento-San Joaquin Delta region contributing to the cumulative impact of sewage and wastewater disposal in the estuary.

Almost 100 percent of municipal sewage* discharged into the Bay and Delta receive either primary (60%) or biological secondary (40%) treatment (Ref. 28). The level of industrial wastewater treatment falls between municipal primary and secondary processes (Ref. 29). Combined wastewater flow rates generated by municipal and industrial sources discharging into the estuary range between 600 and 700 million gallons per day (mgd). Ten percent of total combined volume of wastewater originates directly from industrial sources (Ref. 28). The predominant delivery mechanism for this wastewater is through submarine outfall pipes located in shallow near shore regions of the Bay.

Understanding the impact of municipal and industrial effluent on the estuarine environment requires consideration of the contaminants found in municipal sewage and industrial wastewater. A primary constituent of municipal effluent is fecal waste. Both municipal and industrial dischargers deliver plant nutrients (espeically nitrogen and phosphorus) into the estuary. Large amounts of nutrient substances stimulate excessive marine plant (especially plankton) growth which in turn generate high levels of biochemical oxygen demand (BOD) in the receiving waters. These nutrients are incorporated into the bottom sediments and stored in deposition reservoirs within the estuary.

Large amounts of halogenated organic compounds (e.g., polychlorinated biphenyls, PCBs) enter the estuary via urban sewage (Ref. 30). Industrial effluent containing a broad range of synthetic organic chemicals (mainly synthesized from petroleum compounds) is regularly pumped into the Bay. Industrial waste dischargers inject a number of potentially toxic trace metals (e.g., lead, mercury and cadmium) into the estuary. These metals in low concentrations are required for biological growth in certain marine organisms, but become toxic in high concentrations.

AGRICULTURAL DRAINAGE

A second category of pollutant sources is agricultural drainage. California agricultural productivity is the highest in the nation. Most of this agriculture is dependent on irrigation, fertilizers and pesticides. Presently, there are over six million acres of irrigated agricultural land within the Central Valley. Irrigation water not lost

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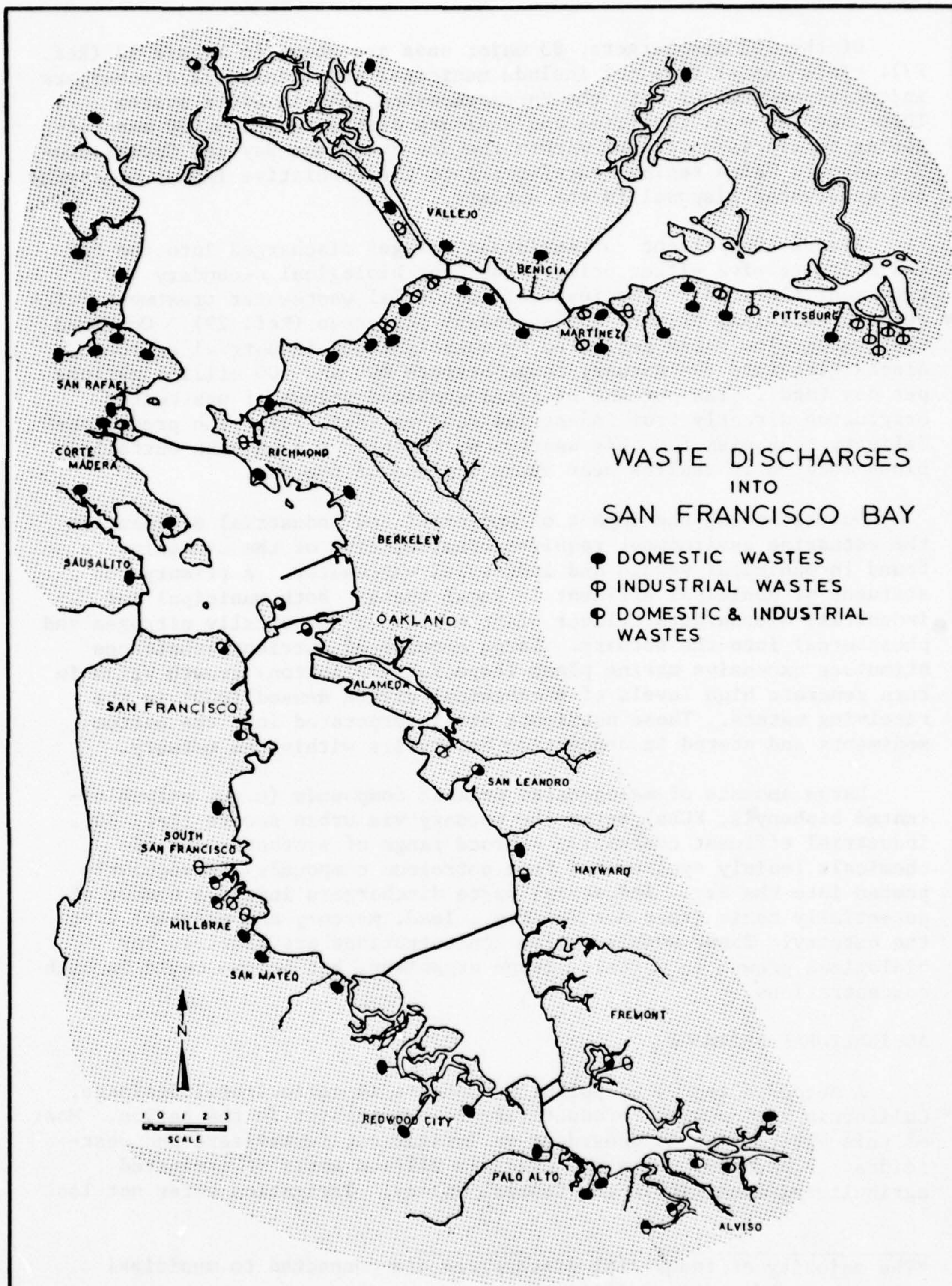
*The majority of industrial dischargers are connected to municipal treatment and sewage facilities.



Source: Scott, M. 1963. The Future of San Francisco Bay. Inst. Govt'al Studies, U.C. Berkeley.

FIGURE 12

via evapotranspiration drains from the fields into local aquifers or into the Sacramento-San Joaquin River system. These agricultural wastewaters transport large quantities of pesticide and fertilizer residues, and animal wastes, as well as nutrients and minerals from the soil into the river system which eventually drains into the Bay.

Chlorinated hydrocarbon pesticides are the most serious contaminants reaching the Bay as a result of agricultural activity. An estimated 10,000-20,000 pounds of this material entered the Bay-Delta system in 1965 (Ref. 28). Pesticides, like heavy metals, are concentrated and stored in bottom sediments.

Agricultural drainage is also a major source of nitrogen and phosphorous compounds. Nitrogen waste loads delivered to the Bay-Delta system constitute four percent of the total nitrogen fertilizers applied to Central Valley agricultural lands (Ref. 28). There is a seasonal regimen associated with the delivery of these potential pollutants to the estuary. Agricultural drainage is concentrated in the irrigation season during the summer.

STORM RUNOFF

Contaminants are washed into the Bay by surface water runoff during winter rainstorms. Runoff occurs on both urban and non-urban (agricultural or undeveloped) land. Non-urban runoff has similar waste load and delivery characteristics as agricultural drainage. The period of maximum runoff occurs in the rainy winter season (October through May). Runoff from these non-urban areas contains high levels of suspended soilds, heavy metals, oil and grease, floatable substances and pesticides.

Urban (street) runoff takes place in settlements with large, contiguous areas of impervious ground surface (e.g., streets, parking lots, other paved and developed areas). Older urban areas (San Francisco, Sacramento, and Vallejo) have combined stormwater and wastewater sewage systems. This means during high intensity and long duration rainstorms treatment facilities exceed maximum capacity. Flows exceeding this capacity are untreated, and raw sewage is diverted directly into the receiving waters of the Bay and its tributaries.

Potential pollutants are deposited and accumulated on city streets between rainstorms. Major contributors of these contaminants (especially oil-grease and lead) include motor vehicle spillage/leakage, and car and truck service stations and maintenance centers (especially during washdown operations), and shipyards.

Contaminated substances conveyed to the Bay by storm runoff are not delivered at constant rate or concentration. Both flows and loads are determined by lag time between succeeding storms, as well as intensity

and duration of individual storms. The first major storm of the rainy season washes more contaminants into the estuary and its tributaries than succeeding storms. The largest amount of these substances is washed off impervious surfaces during the first two hours of a storm (Ref. 18). The predominant contaminant introduced into the Bay system by urban runoff is oil and grease.

AERIAL FALLOUT

Aerial fallout delivers various types of airborne contaminants to the Bay system. Fallout substances dropped into the Bay include residues (lead and hydrocarbons) from motor vehicle and aircraft exhausts, particulate matter from industrial and domestic smokestacks and chimneys, remnants of pesticides and fertilizers sprayed on crops as well as non-lethal amounts of radioactive matter.

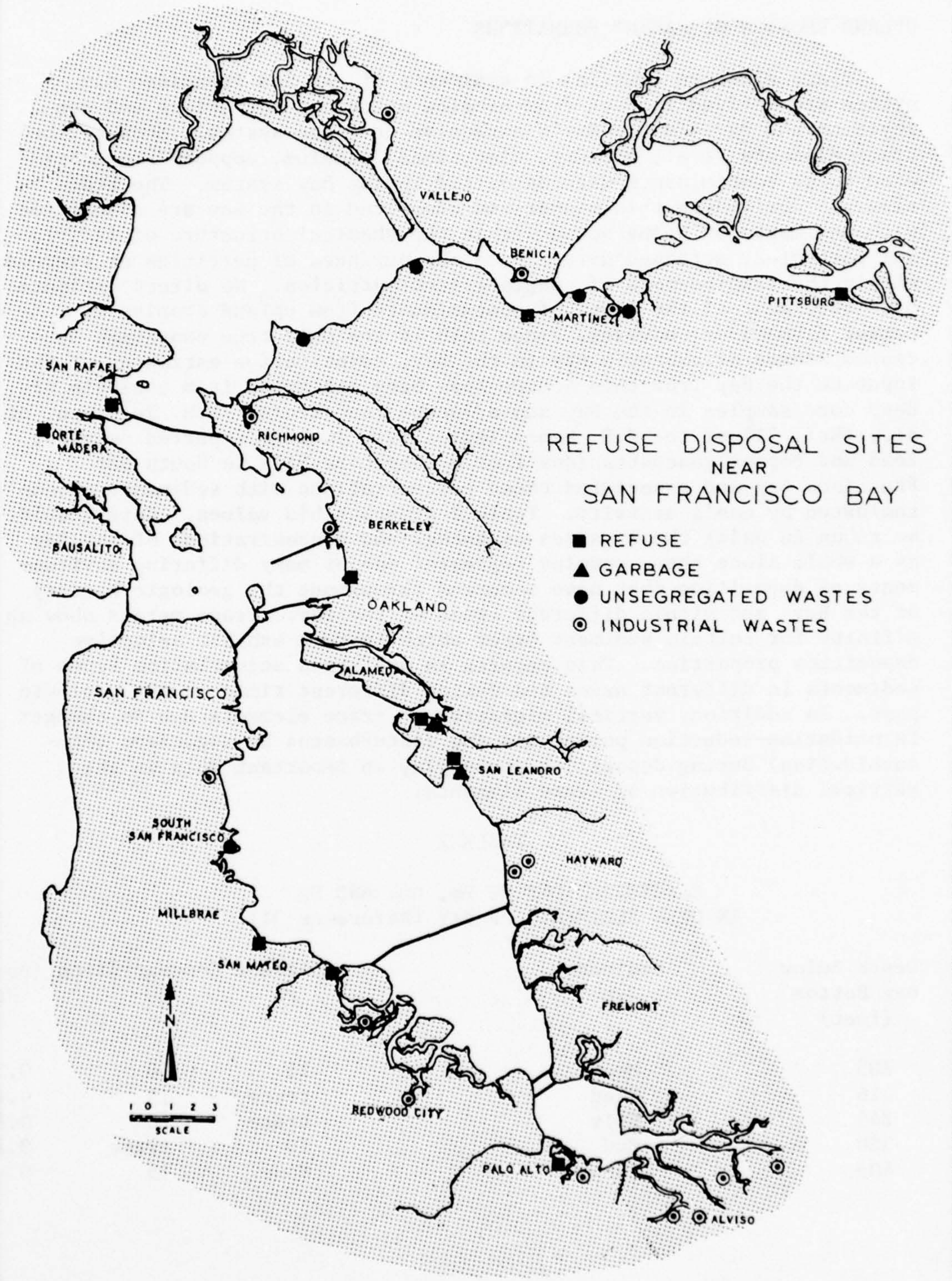
VESSEL DISCHARGE

Recreational (including houseboats), commercial, and naval vessels underway, moored or docked on the Bay introduce contaminants into the estuary deliberately and accidentally. Trash and garbage may be thrown overboard and raw sewage is pumped directly into the receiving waters. Approximately 2,000 lbs. of BOD per day is injected into the Bay from watercraft (Ref. 28). Contamination occurs from petroleum residues from ships.

Accidental oil spills from vessels occur as a result of collisions with other watercraft and shore structures. Anti-fouling paints exude poisons into adjacent waters. Anti-fouling paint poisons contain a range of constituents including copper, mercury, zinc, lead, chromium, arsenic and PCBs. Surface sediments in harbors may contain large reservoirs of anti-fouling paint residues. Watercraft using sacrificial zinc anodes to control galvanic corrosion are sources of zinc contamination. Vessels consuming leaded-gasoline as fuel release lead residues into Bay waters.

SOLID WASTE DISPOSAL SITES

Solid waste disposal sites are additional sources of contaminants. Solid waste material consists of refuse, garbage and sewage sludge. In 1967, 13.5 million tons of solid waste was produced within the Bay-Delta region. There are 49 disposal sites located adjacent to the Bay and tributary waters as shown on Figure 13. Contaminants are transported into contiguous estuarine and riverine waters by direct dumping, ebbtide flow especially during tropic tidal and storm surge conditions, seepage resulting from saturation caused by rainfall, poor drainage and excessive applied water to containment levees and dikes.



Source: Scott, M. 1963.

FIGURE 13

UPLAND EROSION OF PARENT FORMATIONS

Trace elements (metals) in sediments of the San Francisco Bay system are derived in part from erosion of parent formations and conveyed to the Bay via the Bay's extensive drainage system. Many of these trace elements (i.e., mercury, zinc, lead, cadmium, copper) are considered to be contaminants when deposited in the Bay system. The trace elements derived in this manner and deposited in the Bay are associated with sediments by being bound within the chemical structure of individual particles, attached directly to the surfaces of particles or trapped within the lattice-work of conglomerated particles. No direct estimates have been made of the input of contaminants from upland erosion of parent formations; however, since this is the only true non-human associated source of contaminants in the Bay, quantitative estimates of the input to the Bay from this source have been attempted from analysis of deep core samples in the Bay and adjacent land areas. D.H. Peterson, et al., (Ref. 31) of the U.S. Geological Survey in 1972 reported mercury, lead and copper concentrations from a deep bore-hole in South San Francisco Bay and associated these concentrations with sediments uncontaminated by man's activity. Table 2 presents his values. Care should be taken in using these values as background concentrations of the Bay as a whole since these samples represent one of many differing environments of deposition that have occurred throughout the geologic history of the Bay and within different areas of the Bay. Trace metals show an affinity for certain sediment types which in turn exhibit selective deposition properties. This results in preferred accumulation types of sediments in different areas and during different times in the geologic past. In addition, vertical migration of trace elements due to changes in oxidation-reduction potentials and disturbances by organisms (bioturbidation) during deposition could play an important role in the vertical distribution of trace elements.

TABLE 2

CONCENTRATIONS OF Pb, Cu, AND Hg
IN DEEP SEDIMENTS OF BAY (Reference 31)

Depth Below Bay Bottom (feet)	Sediment Type	Element Concentration (ppm) Pb	Cu	Hg
205	Mud	15	50	0.36
216	Sand	trace	15	0.15
245	Silt	trace	20	0.32
350	Mud	10	trace	0.28
405	Sand	None	15	0.06

PREVIOUS POLLUTION SAMPLING

In addition to sampling specific to this study, three other principal sources of information were used. These sources include pollution analysis of bottom sediments in Federally maintained and proposed navigation channels, permit applications for non-Federal dredging, and specific reports concerned with the pollution status of sediments in the Bay.

CORPS OF ENGINEERS POLLUTION SAMPLES

Pollution samples have been obtained by the Corps of Engineers for all active maintenance dredging projects since 1970. In addition, pollution samples are taken for all proposed navigation projects during feasibility studies. Inclosure 1 includes an index of all pollution samples taken by the Corps of Engineers through 1974, the results of chemical analysis and maps showing location of samples. Because of the frequently changing criteria or guidelines for the acceptability of dredged sediment for aquatic disposal, the parameters included in analysis of samples from dredging projects differ greatly from project to project and from year to year. For example, no 1973 samples include bulk sediment; all analysis are elutriates. Inclosure 1 includes analyses of water samples, suspended sediment samples, bottom sediment samples, and elutriates. For the purpose of this investigation, emphasis will be placed on bulk sediment analysis of the parameters lead, zinc, mercury, cadmium, copper, oil and grease, volatile solids, chemical oxygen demand, and total Kjeldahl nitrogen.

To make relative comparisons of contaminant concentrations within dredged channels of the Bay, it becomes necessary to treat the data statistically. Table 3 is a summary of the mean, standard deviation and range of contaminant concentrations in dredged channels of North (including Carquinez Strait and Suisun Bay), Central and South San Francisco Bay and San Francisco Bay, Main Ship Channel.

Generally, dredged channels in Central San Francisco Bay have lower mean concentrations of lead, zinc, cadmium, copper, oil and grease, volatile solids and total Kjeldahl nitrogen than do channels in North and South Bay. Mean concentration of mercury in channels of Central Bay slightly exceed that in North Bay and the mean concentration of chemical oxygen demand in channels of Central Bay is slightly greater than channels in South Bay.

TABLE 3

MEAN CONCENTRATION OF CONTAMINANTS IN DREDGED CHANNELS
1970-1974

Description	Number of Samples	Mean ppm	Standard Deviation ppm	Range ppm
LEAD				
North San Francisco Bay	229	38.8		3-124
Pinole Shoal	54	20.4	8.8	7-43
Napa River	22	21.6	17.4	3-77
Sonoma Creek	9	30.4	22.0	10-81
Petaluma River	21	41.2	14.1	12-80
Point Davis	7	33.7	12.0	17-46
Mare Island St.	88	58.8	20.4	26-124
Carquinez St. & Suisun Bay	28	26.7	16.6	9-66
Central San Francisco Bay	347	23.6		3-153
West Richmond Bay	30	16.7	4.1	9-28
Southampton Shoal	34	15.7	4.9	10-30
Richmond Outer Harbor	76	28.3	24.8	60-150
Richmond Long Wharf	103	29.6	17.2	6-153
Richmond Inner Harbor	29	23.9	18.2	7-80
Sausalito	75	16.8	16.1	3-89
South San Francisco Bay	285	47.9		4-286
Oakland Outer Harbor	71	49.3	49.7	5-23
Oakland Inner Harbor	33	58.3	38.3	12-144
Alameda N.A.S.	94	49.3	29.7	5-150
Islais Creek	45	30.9	29.1	5-50
San Leandro	5	67.2	13.1	52-80
San Bruno Shoal	10	11.7	15.1	4-54
Redwood City	27	65.2	64.0	5-286
Main Ship Channel'	8	11.0	7.9	1-27
All Dredged Channels	869	35.5	33.1	1-286
ZINC				
North San Francisco Bay	229	126.1		31-624
Pinole Shoal	54	72.2	24.0	35-123
Napa River	22	86.3	36.2	32-175
Sonoma Creek	9	95.8	43.8	37-172
Petaluma River	21	112.0	41.4	31-188
Point Davis	7	87.9	21.2	65-115
Mare Island St.	88	193.3	69.0	84-624
Carquinez St. & Suisun Bay	28	72.7	34.5	45-174
Central San Francisco Bay	347	87.4		20-549
West Richmond Channel	30	55.3	8.9	39-73
Southampton Shoal	34	54.5	9.9	40-73
Richmond Outer Harbor	76	98.0	79.9	46-549
Richmond Long Wharf	103	104.3	28.7	38-218
Richmond Inner Harbor	29	90.9	55.8	20-240
Sausalito	75	80.0	37.4	32-218
South San Francisco Bay	285	120.0		10-405
Oakland Outer Harbor	71	136.1	95.1	10-405
Oakland Inner Harbor	33	141.3	86.5	23-310
Alameda N.A.S.	94	131.7	57.3	16-380
Islais Creek	45	62.9	15.9	23-103
San Leandro	5	147.8	14.5	132-161
San Bruno Shoal	10	41.6	12.0	22-63
Redwood City	27	138.0	79.0	41-343

TABLE 3 (Cont'd)

Description	Number of Samples	Mean ppm	Standard Deviation ppm	Range ppm
Main Ship Channel	8	41.4	19.2	18-79
All Dredged Channels	869	108.1	68.1	1-624
MERCURY				
North San Francisco Bay	232	0.41		0.01-4.0
Pinole Shoal	54	0.29	0.54	0.05-4.0
Napa River	22	0.33	0.17	0.01-0.46
Sonoma Creek	9	0.40	0.23	0.11-0.81
Petaluma River	21	0.57	0.24	0.20-0.90
Point Davis	7	0.28	0.19	0.06-0.38
Mare Island St.	88	0.56	0.43	0.02-1.6
Carquinez St. & Suisun Bay	31	0.21	0.22	0.01-0.80
Central San Francisco Bay	347	0.47		0.03-10.5
West Richmond Channel	30	0.31	0.21	0.03-1.1
Southampton Shoal	34	0.38	0.13	0.10-0.60
Richmond Outer Harbor	76	0.46	0.33	0.10-1.9
Richmond Long Wharf	103	0.53	0.27	0.10-1.7
Richmond Inner Harbor	29	0.40	0.29	0.03-1.0
Sausalito	75	0.55	1.22	0.13-10.5
South San Francisco Bay	285	0.78		0.01-10
Oakland Outer Harbor	71	0.46	0.29	0.01-1.3
Oakland Inner Harbor	33	1.05	1.20	0.008-4.9
Alameda Inner Harbor	71	1.05	2.14	0.08-10.0
Islais Creek	45	0.84	0.94	0.12-5.6
San Leandro	5	0.18	0.03	0.14-0.2
San Bruno Shoal	10	0.15	0.15	0.17-0.60
Redwood City	27	0.42	0.27	0.11-1.2
Main Ship Channel	8	0.02	0.03	0.002-0.08
All Dredged Channels	872	0.55	0.92	0.002-10.0
CADMIUM				
North San Francisco Bay	113	2.56		0.70-8.3
Pinole Shoal	-	-	-	-
Napa River	-	-	-	-
Sonoma Creek	-	-	-	-
Petaluma River	15	1.69	0.24	1.2-2.0
Point Davis	-	-	-	-
Mare Island St.	98	2.69	1.54	0.70-8.3
Carquinez St. & Suisun Bay	-	-	-	-
Central San Francisco Bay	266	1.04		0.3-3.4
West Richmond Channel	17	0.56	0.14	0.3-0.80
Southampton Shoal	26	0.86	0.21	0.50-1.3
Richmond Outer Harbor	57	1.24	0.50	0.50-2.1
Richmond Long Wharf	79	1.01	0.48	0.40-2.2
Richmond Inner Harbor	12	1.69	0.79	0.70-3.4
Sausalito	75	0.98	0.35	0.33-2.4
South San Francisco Bay	198	1.84		0.05-15.6
Oakland Outer Harbor	61	1.45	2.43	0.05-15.6
Oakland Inner Harbor	12	1.62	0.68	0.80-3.24
Alameda N.A.S.	52	1.82	1.05	0.48-4.6
Islais Creek	40	2.30	1.30	0.11-3.8
San Leandro	-	-	-	-
San Bruno Shoal	10	0.65	0.51	0.28-2.0
Redwood City	23	2.71	1.56	0.35-4.8

TABLE 3 (Cont'd)

Description	Number of Samples	Mean ppm	Standard Deviation ppm	Range ppm
Main Ship Channel	-	-	-	-
All Dredged Channels	567	1.59	1.37	0.05-15.6
COPPER				
North San Francisco Bay	45	85.0		53-117
Pinole Shoal	-	-	-	-
Napa River	-	-	-	-
Sonoma Creek	-	-	-	-
Petaluma River	-	-	-	-
Point Davis	-	-	-	-
Mare Island St.	45	85.0	19.5	53-117
Carquinez St. & Suisun Bay	-	-	-	-
Central San Francisco Bay	226	34.4		4-104
West Richmond Channel	17	20.2	3.5	14-27
Southampton Shoal	26	25.3	6.4	13-43
Richmond Outer Harbor	50	48.6		20-104
Richmond Long Wharf	49	50.0	8.5	32-68
Richmond Inner Harbor	9	49.7	23.5	21-84
Sausalito	75	19.2	9.3	4-37
South San Francisco Bay	109	38.5		6-85
Oakland Outer Harbor	35	35.7	25.2	7-85
Oakland Inner Harbor	-	-	-	-
Alameda N.A.S.	29	53.0	12.9	22-67
Islais Creek	12	19.3	10.3	6-38
San Leandro	-	-	-	-
San Bruno Shoal	10	22.9	-	12-60
Redwood City	23	41.5	16.5	19-76
Main Ship Channel	-	-	-	-
All Dredged Channels	380	41.6	25.5	4-117
OIL - GREASE				
North San Francisco Bay	223	700		60-3100
Pinole Shoal	54	400	200	100-1100
Napa River	22	700	400	100-1900
Sonoma Creek	9	1000	1000	200-1800
Petaluma River	21	900	400	200-1800
Point Davis	7	300	200	60-530
Mare Island St.	79	800	600	100-3100
Carquinez St. & Suisun Bay	31	500	400	100-1600
Central San Francisco Bay	271	520		10-6000
West Richmond Channel	30	100	100	30-200
Southampton Shoal	34	200	100	30-700
Richmond Outer Harbor	76	600	900	10-6000
Richmond Long Wharf	102	700	400	80-1800
Richmond Inner Harbor	29	500	700	50-2200
Sausalito	-	-	-	-
South San Francisco Bay	226	1100		20-8400
Oakland Outer Harbor	71	1400	1500	20-8400
Oakland Inner Harbor	16	650	420	90-1600
Alameda N.A.S.	78	1350	900	100-3000
Islais Creek	35	500	300	100-1500
San Leandro	5	1200	600	500-1900
San Bruno Shoal	3	100	0	100-100
Redwood City	18	800	600	200-1600

TABLE 3 (Cont'd)

Description	Number of Samples	Mean ppm	Standard Deviation ppm	Range ppm
Main Ship Channel	7	700	400	100-1000
All Dredged Channels	727	800	800	10-8400
VOLATILE SOLIDS	$x10^4$	$x10^4$	$x10^4$	$x10^4$
North San Francisco Bay	161	6.09		1.1-16.6
Pinole Shoal	49	5.11	1.70	1.7-8.5
Napa River	22	6.06	2.20	2.8-11.6
Sonoma Creek	9	7.59	3.94	2.3-16.6
Petaluma River	6	6.62	2.58	1.7-8.2
Point Davis	7	3.69	1.49	1.6-5.5
Mare Island St.	37	7.99	0.74	5.9-9.8
Carquinez St. & Suisun Bay	31	5.41	2.47	1.1-9.3
Central San Francisco Bay	118	5.82		1.1-9.2
West Richmond Channel	13	3.39	0.80	2.2-4.4
Southampton Shoal	9	5.39	1.56	3.7-8.5
Richmond Outer Harbor	30	5.68	1.48	3.3-9.2
Richmond Long Wharf	46	6.61	0.99	4.7-8.7
Richmond Inner Harbor	21	5.95	1.82	1.1-8.0
Sausalito	-	-	-	-
South San Francisco Bay	139	6.34		0.7-10.0
Oakland Outer Harbor	28	6.20	2.19	1.3-10.5
Oakland Inner Harbor	21	4.38	2.38	0.7-7.9
Alameda N.A.S.	67	6.94	2.12	0.96-12
Islais Creek	-	-	-	-
San Leandro	5	8.64	0.72	8-9.6
San Bruno Shoal	-	-	-	-
Redwood City	18	5.95	2.12	0.78-8.1
Main Ship Channel	7	1.74	1.01	1.0-3.9
All Dredged Channels	425	6.03	2.22	0.7-16.6
CHEMICAL OXYGEN DEMAND		$x10^4$	$x10^4$	$x10^4$
North San Francisco Bay	161	4.10		0.3-21.4
Pinole Shoal	49	3.02	1.28	0.5-5.0
Napa River	22	4.03	3.40	1.1-17.0
Sonoma Creek	9	6.42	6.05	0.45-21.4
Petaluma River	6	4.07	1.19	0.72-6.3
Point Davis	7	2.03	1.45	0.39-3.6
Mare Island St.	37	5.21	0.64	3.5-7.0
Carquinez St. & Suisun Bay	31	4.35	3.19	0.3-13.3
Central San Francisco Bay	194	4.25		0.5-10.3
West Richmond Channel	13	2.14	1.32	0.5-5.4
Southampton Shoal	8	2.58	1.08	1.1-4.5
Richmond Outer Harbor	30	4.19	1.18	2.7-7.95
Richmond Long Wharf	47	3.93	0.80	2.4-5.39
Richmond Inner Harbor	21	4.37	2.08	1.0-10.0
Sausalito	75	4.98	1.85	0.94-10.3
South San Francisco Bay	178	4.18		0.10-9.6
Oakland Outer Harbor	28	3.99	1.40	0.17-6.7
Oakland Inner Harbor	21	3.89	2.78	0.10-9.6
Alameda N.A.S.	62	5.16	1.86	0.80-8.7
Islais Creek	15	3.13	1.78	0.50-5.5
San Leandro	5	5.20	0.64	4.3-5.9
San Bruno Shoal	17	2.37	1.42	0.23-4.8
Redwood City	30	3.89	2.05	0.35-9.3

TABLE 3 (Cont'd)

Description	Number of Samples	Mean ppm	Standard Deviation ppm	Range ppm
Main Ship Channel	-	-	-	-
All Dredged Channels	541	4.12	2.19	0.10-21.4
TOTAL KJELDAHL NITROGEN				
North San Francisco Bay	161	900		100-5200
Pinole Shoal	49	900	500	200-2300
Napa River	22	1500	800	400-3000
Sonoma Creek	9	2200	1700	100-5200
Petaluma Rier	6	1300	600	200-2000
Point Davis	7	800	400	400-1400
Mare Island St.	37	800	700	100-1900
Carquinez St. & Suisun Bay	31	900	700	100-2200
Central San Francisco Bay	192	800		70-2900
West Richmond Channel	13	400	100	200-600
Southampton Shoal	8	700	200	400-1100
Richmond Outer Harbor	30	1000	400	200-1800
Richmond Long Wharf	47	1400	600	70-2900
Richmond Inner Harbor	21	1200	500	400-1900
South San Francisco Bay	166	1400		100-9600
Oakland Outer Harbor	28	1350	570	200-2600
Oakland Inner Harbor	4	780	510	300-1100
Alameda N.A.S.	67	1600	1300	100-9600
Islais Creek	15	1300	600	500-2400
San Leandro	5	2100	300	1800-2400
San Bruno Shoal	17	1300	900	300-3800
Redwood City	30	900	900	110-2900
Main Ship Channel	8	200	200	
All Dredged Channels	527	1000	900	50-9600

The mean lead concentrations for the channels of North San Francisco Bay, Central Bay, South Bay, and the San Francisco Bay Main Ship Channel are, respectively; 38.8 ppm, 23.6 ppm, 47.9 ppm, and 10.9 ppm. The highest mean lead concentraticns in dredged channels occur at Mare Island Strait (58.8 ppm) in North San Francisco Bay, and Oakland Inner Harbor (58.3 ppm) and Redwood City Harbor (65.2 ppm) in South San Francisco Bay. Other areas with high mean lead concentrations are: Petaluma River (41.2 ppm) in North Bay and Oakland Outer Harbor (49.3 ppm) and Alameda Naval Air Station (49.3 ppm) in South Bay. The greatest ranges of lead concentrations in dredged channels are also found in these areas. For instance, in Redwood City Harbor, lead concentrations in bottom sediments range from five parts per million to 286 parts per million. Central San Francisco Bay Channel sediments, on the whole, have the lowest mean lead concentration in the Bay. Pinole Shoal (20.4 ppm) in North Bay, West Richmond Cchannel (16.7 ppm) and Southampton Shoal (15.7 ppm) in Central Bay, and San Bruno Shoal (11.7 ppm) in South Bay have the lowest mean lead concentrations.

The mean zinc concentrations for North Bay, Central Bay, South Bay and the Main Ship Channel are, respectively: 126.1 ppm, 87.4 ppm, 120.8 ppm, and 41.4 ppm. The highest mean zinc concentrations occur in the same dredged channels as does high mean lead concentrations; i.e., Mare Island Strait (193.3 ppm) in North San Francisco Bay, and Oakland Inner Harbor (141.3 ppm) and Redwood City Harbor (138.0 ppm) in South Bay. Other areas with high mean zinc concentrations are: Oakland Outer Harbor (136.1 ppm) and Alameda Naval Air Station (131.7 ppm). As with mean lead concentrations, Central San Francisco Bay navigation channels have the lowest mean zinc concentrations on the Bay. Based on ten samples, San Bruno Shoal (41.6 ppm) has the lowest mean zinc concentration of channels in the Bay. Other areas with low mean zinc concentrations are: Pinole Shoal Channel (76.2 ppm) in North Bay, West Richmond Channel (55.3 ppm) and Southampton Shoal (54.5 ppm) in Central Bay, and Islais Creek (62.9 ppm) in South Bay.

The mean mercury concentrations for 232 samples in navigation channels of North San Francisco Bay, Central Bay, South Bay, and the San Francisco Bar, Main Ship Channel are, respectively: 0.41 ppm, 0.47 ppm, 0.78 ppm, and 0.02 ppm. The highest mean mercury concentrations are found in South Bay; namely, at Alameda Naval Air Station (1.10 ppm) and Oakland Inner Harbor (1.05 ppm). Some channels such as Sausalito in Central Bay and Islais Creek in South Bay have isolated cases of exceedingly high values of mercury. The lowest mercury concentrations are found in Carquinez Straits, Suisun Bay (0.21 ppm) and Pinole Shoal Channel (0.29 ppm) in North San Francisco Bay; West Richmond Channel (0.31 ppm) and Southampton Shoal (0.38 ppm) in Central Bay; and San Leandro Marina (0.18 ppm) and San Bruno Shoal (0.27 ppm) in South Bay.

The mean cadmium concentrations in navigation channels of North San Francisco Bay, Central Bay, and South Bay are, respectively: 2.56 ppm,

1.04 ppm, and 1.84 ppm. No cadmium analysis has been performed on bottom sediments from the San Francisco Bay, Main Ship Channel. The highest mean cadmium concentrations in dredged channels are found at Mare Island Strait (2.69 ppm) in North Bay, Islais Creek (2.30 ppm) and Redwood City Harbor (2.71 ppm) in South Bay. Other navigation channels with high mean cadmium concentrations are: Petaluma River (1.69 ppm), Richmond Inner Harbor (1.69 ppm), Oakland Inner Harbor (1.62 ppm) and Alameda Naval Air Station (1.82 ppm). In a few cases individual sediment samples show extremely high cadmium values. Two such examples are; one Mare Island Strait sample with a concentration of 8.3 ppm and one sample from Oakland Outer Harbor with a concentration of 15.6 ppm. On the whole, the lowest mean cadmium concentrations are found in Central San Francisco Bay channels. West Richmond Channel (0.56 ppm), Southampton Shoal (0.86 ppm), Sausalito Channel (0.98 ppm), and San Bruno Shoal (0.65 ppm) have the lowest mean cadmium concentrations of all navigation channels in the Bay.

The mean copper concentrations in Mare Island Strait, Central San Francisco Bay, and South Bay are, respectively: 85.02 ppm, 34.37 ppm, and 38.52 ppm. Mare Island Strait, the only navigation channel in North Bay having copper analysis, has the largest mean copper concentration. Other channels with high mean copper concentrations are: Richmond Outer Harbor (48.58 ppm), Richmond Long Wharf and Point Molate (50.02 ppm), Richmond Inner Harbor (49.67 ppm), and Alameda Naval Air Station (52.97 ppm). The channels with the lowest mean copper concentrations are: West Richmond Channel (20.18 ppm) and Sausalito Channel (19.21 ppm) in Central Bay, and Islais Creek (19.33 ppm) and San Bruno Shoal (22.9 ppm) in South Bay.

The mean Oil-Grease (O-G) concentrations in North Bay, Central Bay, South Bay, and the San Francisco Bar, Main Ship Channel are, respectively: 700 ppm, 520 ppm, 1100 ppm, and 700 ppm. The highest mean O-G concentrations occur in Oakland Outer Harbor (1400 ppm) and Alameda Naval Air Station (1350 ppm) in South Bay. Large concentrations from individual samples have been encountered in Richmond Outer Harbor (6000 ppm) and Oakland Outer Harbor (8400 ppm). The lowest mean oil and grease concentrations occur at West Richmond Channel (100 ppm) and Southampton Shoal (200 ppm) in Central San Francisco Bay.

The mean volatile solids concentrations in navigation channels of North San Francisco Bay, Central Bay, South Bay, and the San Francisco Bar, Main Ship Channel are, respectively: 6.09×10^4ppm, 5.82×10^4ppm, 6.34×10^4ppm, and 1.74×10^4ppm. The highest mean concentrations are found at Mare Island Strait (7.99×10^4ppm) and Sonoma Creek (7.59×10^4ppm) in North San Francisco Bay, and San Leandro Marina (8.64×10^4ppm) in South San Francisco Bay. The lowest mean concentrations of volatile solids are found at Point Davis (3.69×10^4ppm) and Southampton Shoal (3.39×10^4ppm).

The mean chemical oxygen demand (COD) concentrations in dredged channels of North Bay, Central Bay, and South Bay are, respectively: 4.10×10^4ppm, 4.25×10^4ppm, and 4.18×10^4ppm. These main values vary only slightly within the entire Bay. The highest mean COD concentrations are found at Sonoma Creek (6.42×10^4ppm) and Mare Island Strait (5.21×10^4ppm) in South Bay. The lowest mean chemical oxygen demands are found at Point Davis (2.03×10^4ppm) in North Bay, West Richmond Channlel (2.14×10^4 ppm) in South Bay.

The mean total Kjeldahl nitrogen (TKN) concentrations in dredged channels of North Bay, Central Bay, South Bay, and the San Francisco Bar, Main Ship Channel are, respectively: 900 ppm, 800 ppm, 1400 ppm, and 200 ppm. The highest mean TKN concentrations in dredged channels are found at Napa River (1500 ppm) and Sonoma Creek (2200 ppm) in North San Francisco Bay, and Alameda Naval Air Station (1600 ppm) and San Leandro Marina (2100 ppm) in South Bay. Central San Francisco Bay navigation channels have the lowest mean TKN concentrations; namely, West Richmond Channel (400 ppm) and Sausalito Channel (300 ppm).

In summary, the distribution of the above nine parameters vary greatly within dredged channels of the San Francisco Bay system. The mean concentrations of parameters listed in Table 3 indicate that the channels of Central Bay, including the Richmond Harbor complex, have lower mean concentrations for most parameters than do channels of North San Francisco Bay and South San Francisco Bay. Open-water channels such as Pinole Shoal Channel in North Bay; West Richmond Channel and Southampton Shoal Channel in Central Bay; and San Bruno Shoal Channel in South Bay have lower mean concentrations than do the partially enclosed channels of well developed harbors; i.e., Redwood City Harbor, Islais Creek, Oakland Harbor, and Richmond Harbor. Mare Island Strait Channel has higher mean concentrations for most of the nine parameters than do other channels in the Bay.

Many of the mean concentrations listed in Table 3 exhibit large standard deviations. These large values indicate a high degree of spread of measured values around the mean concentration. Three factors immediately become apparent as causes for the large standard deviations. First, the samples used to arrive at the mean concentrations in Table 3 are a result of four years of data collections in dredged channels. Examination of Inclosure 1 will show large annual concentration variations in individual channels. Second, a large majority of samples analysed in Inclosure 1 represent only surface samples; these surface samples with few exceptions have substantially larger concentrations for all nine parameters. Generally, surface sediment concentrations exceed those of deeper samples by 30 to 50 percent. In some cases the deeper sediment concentrations may be exceeded by the surface sediments by as much as 150 percent. Third, the spatial variation of parameter concentrations vary greatly within individual channels. These three factors will be discussed in greater detail in later sections.

OTHER REPORTS

A number of investigations have been performed that deal specifically with levels of certain constituents in San Francisco Bay sediments that are important when considering the effects of contaminants on the environment of the Bay System.

A study of the distribution of contaminants contained in bottom sediments at Alameda Naval Air Station was conducted by the Corps of Engineers in June 1973. The purpose of the study was to evaluate the chemical characteristics of bottom sediments within the Station's ship channel, turning basin and berthing area in anticipation of future maintenance dredging activities. Included in the report is a summary of the dredging history, previous pollution sampling and analysis, comparison of contaminant levels with other similar areas in the Bay, supplementary sampling program results and a discussion of distribution of contaminants in terms of physical processes and factors responsible for the distribution. Briefly, the report concluded that restricted circulation and high shoaling rates contribute greatly to the high pollution levels in sediments at the Station. Pollutant distribution relationships of surface sediments at the Station indicate that industrial waste discharges in the basin are the prime contributors of pollutant levels found there. Contaminant concentrations are included in Table 3.

The U.S. Geological Survey in 1971 and 1972 performed reconnaissance surveys of surface sediment trace elements mercury, lead and copper in the Bay (Refs. 31 and 32). They found the highest surface sediment concentrations of these elements in natural and artificial tributaries and along the Bay margins. Intermediate concentrations occur in fine sediment (silt-clay) on the shoal areas and the lowest concentrations occur in the channels where sand is abundant and currents are strongest. Although particle size analysis was not conducted, it was inferred that high concentrations of these trace metals are associated with fine sediments, based on increases in trace metal concentrations with higher organic content in surface sediments. For comparative purposes the abundance of mercury, lead and copper in surface sediments and one deep and two shallow cores was examined. Results indicate a near-surface enrichment of these three metals that is apparently unrelated to the effect of grain size. U.S.G.S. stated that a clear distinction between natural background levels (see section on Pollutant Sources) and man's contribution cannot be made based on their data since there is a wide natural range in metal concentrations in sediment and soil, and because the concentrations in most Bay sediment analyzed fall well within that range. Table 4 is a summary of the mean, range and standard deviation of U.S.G.S. data.

TABLE 4

MEAN CONCENTRATION OF U.S.G.S. MERCURY, LEAD AND COPPER SAMPLES (Reference 31 & 32)

Description	Number of Samples*	Mean ppm	Standard Deviation ppm	Range ppm
MERCURY				
Suisun Bay	38	0.35	0.43	0.02-2.0
San Pablo Bay	41	0.27	0.26	0.04-1.2
Central Bay	41	0.18	0.13	0.04-.75
South Bay	82	0.44	0.75	0.04-6.43
Entire Bay	202	0.34	0.53	0.02-6.34
LEAD				
Suisun Bay	39	13.2	15.9	10-70
San Pablo Bay	40	36.0	22.3	10-100
Central Bay	41	29.6	25.7	10-70
South Bay	83	57.2	63.9	10-500
Entire Bay	203	39.0	47.1	10-500
COPPER				
Suisun Bay	40	27.6	34.3	5-150
San Pablo Bay	40	42.0	27.1	5-100
Central Bay	41	25.5	19.9	5-70
South Bay	85	44.6	39.2	5-150
Entire Bay	206	37.0	33.0	5-150

*Calculations of the mean concentrations are based on the area divisions. Two high lead values were excluded from the calculations; one sample in South Bay (3,000 ppm) and one sample in San Pablo Bay (10,000 ppm). One high copper value was excluded from San Pablo Bay (10,000 ppm). Where no value was detected or only a trace was detected 0 ppm was used in determining the mean concentration.

As with the Corps of Engineers pollution samples in dredged channels, U.S.G.S. data in Table 4 reflect large standard deviations, indicating a high degree of spread of measured values around the mean concentrations. Since the data in Table 4 represents only surface samples, and is assumed to have been obtained within a time frame as not to reflect annual variations in parameter concentrations, it can be inferred that the wide range of concentrations within different areas of the Bay is the result of the sources of the trace metals and the distribution forces in the Bay.

W. L. Bradford (1972) conducted a four month study of "The Distribution and Movement of Zinc and Other Heavy Metals in South San Francisco Bay" (Ref. 33). Bradford attempted to determine the net transport of a trace metal, zinc, into the system, out of the system and, thence, between the solid and solution phases by evaluating the following parameters: (1) the net direction and rate of zinc exchange between sediments and overlying water; (2) the distributions of zinc in the aqueous phase and zinc, iron, manganese, and copper in suspended solids, and variations in the distributions in time and space; (3) the extent of organic chelation in the aqueous phase; (4) the rate of discharge of zinc from the sediment-water interface as determined by detecting a gradient in the zinc concentration in the water column with respect to the interface; and (5) the concentrations of iron, manganese, zinc, copper, cobalt, nickel, and lead in the sediments and interstitial water.

Results of the analysis of four trace metals (Fe, Mn, Zn, Cu) in suspended solids indicated that there was no significant difference in concentration with water depth or station, suggesting that the distribution of suspended solids and trace metals in those solids is spatially homogenous. Table 5 is the results of the trace metal analysis of suspended solids.

Bottom sediments were analyzed for iron, manganese, zinc, copper, cobalt, nickel and lead. Core samples were analyzed at increments of 3 centimeter to a depth of 12 centimeter. Each sample was separated into two size fractions; less than 20 microns and between 20 microns and 2,000 microns. The results of analysis are shown in Table 6.

The means of all metal concentrations except nickel were found to be significantly different between the two size fractions in Table 6. Metal concentrations are higher in the less than 20 micron fraction over the 20 micron to 2,000 micron fraction by a factor of two in iron, manganese and cobalt; a factor of three in copper; and a factor of five in lead. Some of the apparent trends that Bradford found are: Manganese is slightly more concentrated in surficial layers in both size fractions; zinc is slightly more concentrated in both size fractions and higher levels are found at the south end of the Bay; and in most samples, the nickel concentrations are greater in the less than 20 micron fraction. Samples just south of the Dumbarton Bridge are higher in the larger size fraction.

TABLE 5

MEAN CONCENTRATION OF Fe, Mn, Zn, Cu FROM ELEVEN SUSPENDED SOLIDS SAMPLES IN SOUTH SAN FRANCISCO BAY (Reference 33)

Description	Mean	Standard Deviation	Range
25 September 1972			
Fe (ppt)	16.3	5.0	8.4-26.9
Mn (ppm)	642	147	252-893
Zn (ppm)	80	39	16-156
Cu (ppm)	29	14	9-60
2 November 1972			
Fe (ppt)	29.8	3.8	21.7-35.7
Mn (ppm)	910	238	551-228
Zn (ppm)	101	68	19-228
Cu (ppm)	40	19	11-75
11 December 1972			
Fe (ppt)	31.8	5	24.7-40.8
Mn (ppm)	797	263	399-1310
Zn (ppm)	111	62	28-229
Cu (ppm)	45	26	12-87
3 January 1973			
Fe (ppt)	38.2	2.6	34.5-43.5
Mn (ppm)	1147	262	748-1430
Zn (ppm)	133	27	84-167
Cu (ppm)	16	9	6-32
Composite			
Fe (ppt)	29	9	8.4-43.5
Mn (ppm)	874.6	298.8	252-1430
Zn (ppm)	106.2	53.8	16-229
Cu (ppm)	32.4	20.7	6-87

TABLE 6

MEAN CONCENTRATIONS OF SEVEN TRACE METALS IN BOTTOM SEDIMENTS
OF SOUTH SAN FRANCISCO BAY (Reference 33)

Description	n	20-2000 Micron Mean	Standard Deviation	Range	<20 Micron Mean	Standard Deviation	Range
Fe (ppt)							
0-3cm	10	23.62	8.01	13.8-38.5	46.31	5.9	42.3-58.7
3-6	10	24.50	13.72	12.4-57.5	46.16	12.12	20.7-71.3
6-9	10	23.40	12.56	10.5-52.3	49.85	3.99	43.2-54.2
9-12	9	22.11	5.47	13.2-32.6	47.40	3.85	41.4-53.4
0-12	39	23.42	10.20	10.5-57.5	47.43	7.24	20.7-71.3
Mn (ppm)							
0-3cm	10	282.2	143.4	173-493	527.1	146.6	326-807
3-6	10	230.1	140.9	79-569	515.8	380.4	154-1508
6-9	10	206.8	95.3	75-350	444.6	146.3	279-776
9-12	9	210.2	66.6	143-330	428.8	76.5	308-561
0-12	39	232.9	116.7	75-569	480.4	218.1	154-1508
Zn (ppm)							
0-3cm	10	53.19	24.35	29.5-109.8	84.33	15.88	59.2-110.5
3-6	10	45.93	21.62	26.1-99	100.04	49.26	30.4-192.8
6-9	10	46.22	24.67	20.9-80.9	96.31	29.28	58.6-164.5
9-12	9	50.11	21.70	18.3-80.6	92.16	32.88	45.8-166.5
0-12	39	48.80	22.40	18.3-109.8	93.20	33.20	30.4-192.8
Cu (ppm)							
0-3cm	10	17.73	10.57	5.2-36.9	33.60	9.69	21.5-42.7
3-6	10	14.50	7.69	7.3-29.1	35.25	16.02	13.6-60.3
6-9	10	15.06	8.97	4.1-30.9	33.64	10.03	18-52.5
9-12	9	11.94	7.13	2.6-20.7	64.80	97.59	21.5-324.4
0-12	39	14.90	8.60	2.6-36.9	41.20	47.80	13.6-324.4
Co (ppm)							
0-3cm	10	2.70	1.21	1.0-4.7	9.19	4.35	4.8-22.5
3-6	10	2.90	1.05	1.3-4.8	8.76	4.06	2.7-14.6
6-9	10	3.14	2.61	0.6-8.9	9.37	3.24	5.5-16.1
9-12	9	3.50	2.13	1.4-8.2	7.94	1.74	4.1-10.2
0-12	39	3.10	1.80	0.6-8.9	8.80	3.60	2.7-22.5
Ni (ppm)							
0-3cm	10	26.84	14.63	12-58.3	27.65	13.51	11.7-51.1
3-6	10	24.92	13.29	10.7-48.3	33.59	26.27	7.0-93.6
6-9	10	24.36	11.16	7.7-42.5	29.71	16.42	10.6-69
6-12	9	25.17	11.08	8.1-38.5	33.80	14.44	16.3-52
0-12	39	25.30	12.20	7.7-58.3	31.40	18.40	7.0-93.6
Pb (ppm)							
0-3cm	10	3.30	3.56	0-12.3	22.38	11.82	10.2-47.3
3-6	10	2.57	2.49	0.4-5.2	17.47	8.30	3.5-35.5
6-9	10	3.61	4.07	0-12.1	19.48	12.29	1.3-45.5
9-12	9	3.18	4.43	0-12.7	15.30	7.64	4.5-33.5
0-12	39	3.20	3.60	0-12.7	19.40	10.80	1.3-47.3

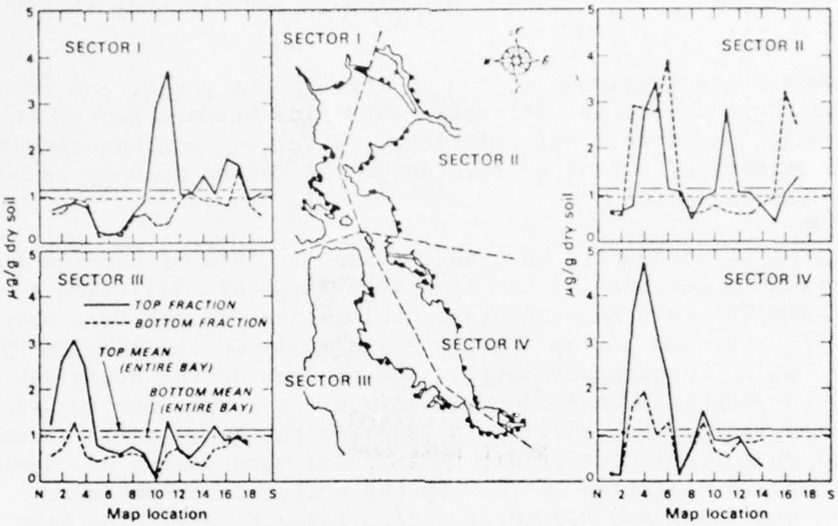
No systematic differences in zinc concentration were observed with depth in the water column, and no concentration gradient was observed close to the sediment-water interface. Bradford suggests that during this season zinc is not released from the sediments or that vertical stirring action disperses the zinc gradient so rapidly that it cannot be observed.

The mean concentrations of zinc in the aqueous phase, and iron and zinc in the suspended solids increased with time between September and January, suggesting functional relationships between concentrations and the season or another parameter related to the season such as temperature or solar radiation.

Moyer, et al. conducted an investigation in 1974 of cadmium levels in the shoreline sediments of San Francisco Bay (Ref. 34). Ten centimeter core samples were obtained from 68 locations in the Bay, then separated into top and bottom fractions and analyzed for cadmium by atomic absorption spectrophotometry. The purpose of the study was twofold: (1) to establish background levels to set a base for future environmental monitoring, and (2) to identify the gross soil and environmental characteristics of hot spots. The mean values of cadmium with one standard deviation in the top and bottom fractions were 1.22 ± 0.99 μg/g (ppm) and 0.93 ± 0.74 μg/g, respectively. The mean value for all 10-cm cores of San Francisco Bay peripheral muds was 1.07 ± 0.89 μg/g. The authors chose to investigate bioexchangeable cadmium as being more meaningful as a contaminant of the environment rather than total cadmium. Bioexchangeable cadmium is that which is in a chemical state that allows it to become incorporated and accumulated in the biological systems of organisms.

Moyer, et al. concluded from their literature search that non-polluted surface soil cadmium content of the world is approximately 2.0 ppm in industrial areas or areas open to the public. River beds and estuary sediments, however, are not disturbed soils. They have a constant influx of solutes from both industrial effluents and dissolved soil components. The deposition of these solutes from chemical precipitation or absorption will be greater in general than that for dry land soils. Cadmium levels in the hills around the San Francisco Bay area ranged from 0.21 ppm to 0.88 ppm. Other areas in the United States somewhat similar to San Francisco Bay whose sediments have been analyzed for cadmium levels are 287 samples in Corpus Christi Bay and Harbor, 0.1-1.9 ppm and 2-130 ppm, respectively; and samples from ten lakes in Wisconsin, 0.2-5.5 ppm.

Moyer's investigation divided San Francisco Bay into four sectors as shown in Figure 14. Sector I, which includes the sparsely industrialized west shore of Central and North San Francisco Bay had a mean top fraction cadmium content of 1.15 ± 0.87 ppm and a mean bottom fraction of 0.70 ± 0.34 ppm. Sector II located along the east shore of Central and North Bay had a mean top fraction concentration of 1.25 ± 0.8 ppm and a



Sector division of the bay and a point by point display of the cadmium levels found in the top and bottom fractions of each core sample. Each sector display progresses from the northern-most sample to a southern-most sample. The bay top fraction and bottom fraction mean values are overlaid to allow for a point to mean comparison.

CADMIUM DISTRIBUTION - SHORELINE SEDIMENTS

SOURCE: MOYER, 1974.

FIGURE 14

mean bottom fraction concentration of 1.54±1.14 ppm. In this sector the incidence of high cadmium was most common in Mare Island and Emeryville mudflat sites. Sector III which includes the west shoreline of South Bay had a mean top fraction value of 1.10±0.78 ppm and a mean bottom fraction value of 0.65±0.24 ppm. Compared to the other sectors, this one had the lowest incidence of cadmium. High top fraction values were found at Hunter's Point (2.62 ppm) and South San Francisco (3.10 ppm). The lowest Bay sediment value was also found in this sector at Redwood City (0.06 ppm). Sector IV located on the east shore of South Bay had a mean top fraction concentration of 1.43±1.41 ppm and a mean bottom fraction concentration of 0.85±0.53 ppm. San Leandro Bay had the most consistently high top fraction values of any point to point area in the Bay.

To fit the data into the format of this study Moyer et al. sampling areas have been rearranged into North San Francisco Bay, Central San Francisco Bay, and South San Francisco Bay. The location of shoreline samples and areas are shown on Figure 14. Table 7 is the data by area of the Bay and the mean, standard deviation and range of cadmium content in shoreline sediments.

Cadmium is not mined outright, but is rather extracted from zinc-lead ore deposits. About one-half the total annual consumption of cadmium is for electroplating in a wide variety of industries. The other half of the industrial use of cadmium is in pigments, plastics, batteries, tires, alloys, cosmetics, and other products. The San Francisco Bay Area has no local sources of cadmium. However, a lead-slag fuming plant at Selby near Carquinez Strait has operated for over 60 years. This plant recently ceased operations. Other possible contributors of cadmium to the Bay might be found in numerous shipbuilding and repair facilities, both civil and military such as Mare Island Naval Shipyard, commercial shipyards at Oakland and San Francisco, and municipal wastewater and sewage. The reserve (mothball) fleet anchored east of Benicia in Suisun Bay could introduce cadmium to the Bay waters through simple dissolution of protective paints over the years. The automobile has several wearing components that contain cadmium; these include tires, brake linings, bearings, paints, motor fuels, and lubricants. The extensive highway network and bridges in the Bay area result in automobiles being another major source of shoreline cadmium.

Moyer, et al. concluded that the shoreline sediments of San Francisco Bay have cadmium concentrations which are similar to levels found in nonpolluted or marginally polluted areas of the world. The highest cadmium levels found in the Bay are 100-1000 times less than known contaminated areas of the world. Sandy soils of the Bay overall exhibit low cadmium levels. Samples taken near developments and industries tended to have elevated cadmium.

TABLE 7

MEAN CONCENTRATION OF CADMIUM IN SHORELINE SEDIMENTS
OF
SAN FRANCISCO BAY (Reference 34)

Description		Cd (ppm)	Description		Cd (ppm)
North San Francisco Bay			Central San Francisco Bay		
San Rafael	Top	0.15	Richardson Bay	Top	1.03
	Bottom	0.20		Bottom	0.59
San Rafael (No)	Top	0.24	Richardson Bay	Top	0.93
	Bottom	0.14		Bottom	0.74
Black Point	Top	0.78	Tiburon	Top	1.03
	Bottom	0.88		Bottom	0.89
Black Point	Top	0.83	Tiburon	Top	1.67
	Bottom	0.97		Bottom	1.56
Highway 37	Top	0.77	Tiburon	Top	1.77
	Bottom	0.67		Bottom	0.78
Highway 37	Top	0.68	Larkspur	Top	1.43
	Bottom	0.65		Bottom	0.81
Highway 37	Top	0.66	Larkspur	Top	1.04
	Bottom	0.61		Bottom	1.05
Highway 37	Top	0.62	Corte Madera	Top	1.00
	Bottom	0.61		Bottom	0.99
Mare Island	Top	0.74	Corte Madera	Top	3.72
	Bottom	2.93		Bottom	0.41
Mare Island	Top	2.74	Corte Madera	Top	2.94
	Bottom	2.86		Bottom	0.39
Mare Island	Top	3.44	Corte Madera	Top	0.89
	Bottom	2.74		Bottom	0.69
Mare Island	Top	1.11	Pt. San Quentin	Top	0.63
	Bottom	3.91		Bottom	0.61
Vallejo	Top	1.08	San Rafael (So)	Top	0.18
	Bottom	0.92		Bottom	0.18
Pinole (No)	Top	0.48	Richmond	Top	0.70
	Bottom	0.68		Bottom	0.88
Pinole	Top	0.96	Albany	Top	0.41
	Bottom	0.64		Bottom	0.99
Pinole	Top	1.04	Emeryville	Top	1.02
	Bottom	0.76		Bottom	3.22
Pt. San Pablo (No)	Top	2.86	Emeryville	Top	1.39
	Bottom	0.68		Bottom	2.55
Pt. San Pablo	Top	1.03			
	Bottom	0.58			
Pt. San Pablo (So)	Top	1.04			
	Bottom	0.61			
South San Francisco Bay					
Palo Alto	Top	0.65	Newark	Top	0.86
	Bottom	0.75		Bottom	0.52
Mountain View	Top	0.53	Newark	Top	0.90
	Bottom	0.48		Bottom	0.68
Mountain View	Top	0.78	Union City-Fremont	Top	1.49
	Bottom	0.36		Bottom	1.27
San Jose	Top	1.23	San Lorenzo	Top	0.75
	Bottom	0.72		Bottom	0.72
San Jose	Top	0.76	San Leandro Marina	Top	0.14
	Bottom	0.76		Bottom	0.14
San Jose	Top	0.94	San Leandro Bay	Top	2.21
	Bottom	1.00		Bottom	1.27
San Jose	Top	0.78	San Leandro Bay	Top	3.25
	Bottom	0.86		Bottom	1.03
Milpitas	Top	0.28	San Leandro Bay	Top	4.69
	Bottom	0.83		Bottom	1.93
Milpitas	Top	0.94	San Leandro Bay	Top	3.64
	Bottom	0.72		Bottom	1.68
Milpitas	Top	0.94	Alameda	Top	0.19
	Bottom	0.86		Bottom	0.15
			Alameda	Top	0.19
				Bottom	0.16

	Mean (ppm)	Standard Deviation	Range (ppm)
North San Francisco Bay			
Top	1.12	0.89	0.15-3.44
Bottom	1.16	1.08	0.14-3.91
Central San Francisco Bay			
Top	1.28	0.88	0.18-177
Bottom	1.02	0.78	0.18-3.22
South San Francisco Bay			
Top	1.26	1.13	0.14-4.96
Bottom	0.74	0.41	0.14-1.93
Entire Bay			
Top	1.22	0.99	0.14-4.96
Bottom	0.93	0.74	0.14-3.91

SEISMIC SUBBOTTOM REFLECTION PROFILING

The objective of the seismic reflection profiling element as discussed in the Work Items section is to delineate and map various subbottom reflection horizons which can be used as a guide for determining the horizontal and vertical distribution of pollutants. One hundred fifty-six miles of continuous seismic subbottom reflection profile records were obtained in the three study areas. The work commenced on 11 October 1972 and was completed on 31 October. Inclosure 2 is the profiling track of the survey vessel and the interpretation of the seismic records. The original seismic reflection records and microfilm duplications are on file in the San Francisco District office. Inclosure 3 is the final report for the seismic reflection profiling by Alpine Geophysical, Inc.

The seismic profiles presented in Inclosure 2 represent major continuous horizons. Many areas were encountered in the Bay System where the outgoing signal was completely attenuated in the near surface sediments. These areas are believed to be of principal significance and therefore a "horizon" representing the limit of penetration has been profiled on the Seismic Reflection Interpretation plates. The limit of penetration is based on a subjective analysis of the data. In general, the limit of penetration is associated with either gaseous layers within the near-surface sediments often indicative of a high organic content or very highly uncompacted silt and clay with a high water content causing excessive scatter of the outgoing signal. Figure 15, an example of the field record shows the limit of penetration and demonstrates that the limit of penetration is caused by the near surface sediments. It should be noted in this example that the subsurface horizons become recognizable after the near surface material has been removed, in this case after dredging in a maintained channel. Another form of "no data" area is characterized by lack of any coherent return. Such areas are noted as no data areas on the interpretation of profiles.

The profiles in Inclosure 2 are plotted to a horizontal scale of 1"=600' with a vertical scale of 1"=10' giving a vertical exaggeration of 60:1. Because of this scale distortion many irregular surfaces where the horizontal extent of the irregularity is less than fifty feet on the original profiles have not been plotted on the interpretation of the profiles.

San Pablo Bay-Carquinez Strait

Fifty miles of seismic reflection profiles shown on Figure 16 were obtained in the San Pablo Bay-Carquinez Strait area. The actual profiling lines are presented in Inclosure 2. This area can be characterized as having shallow subsurface reflections with very few deep reflections.

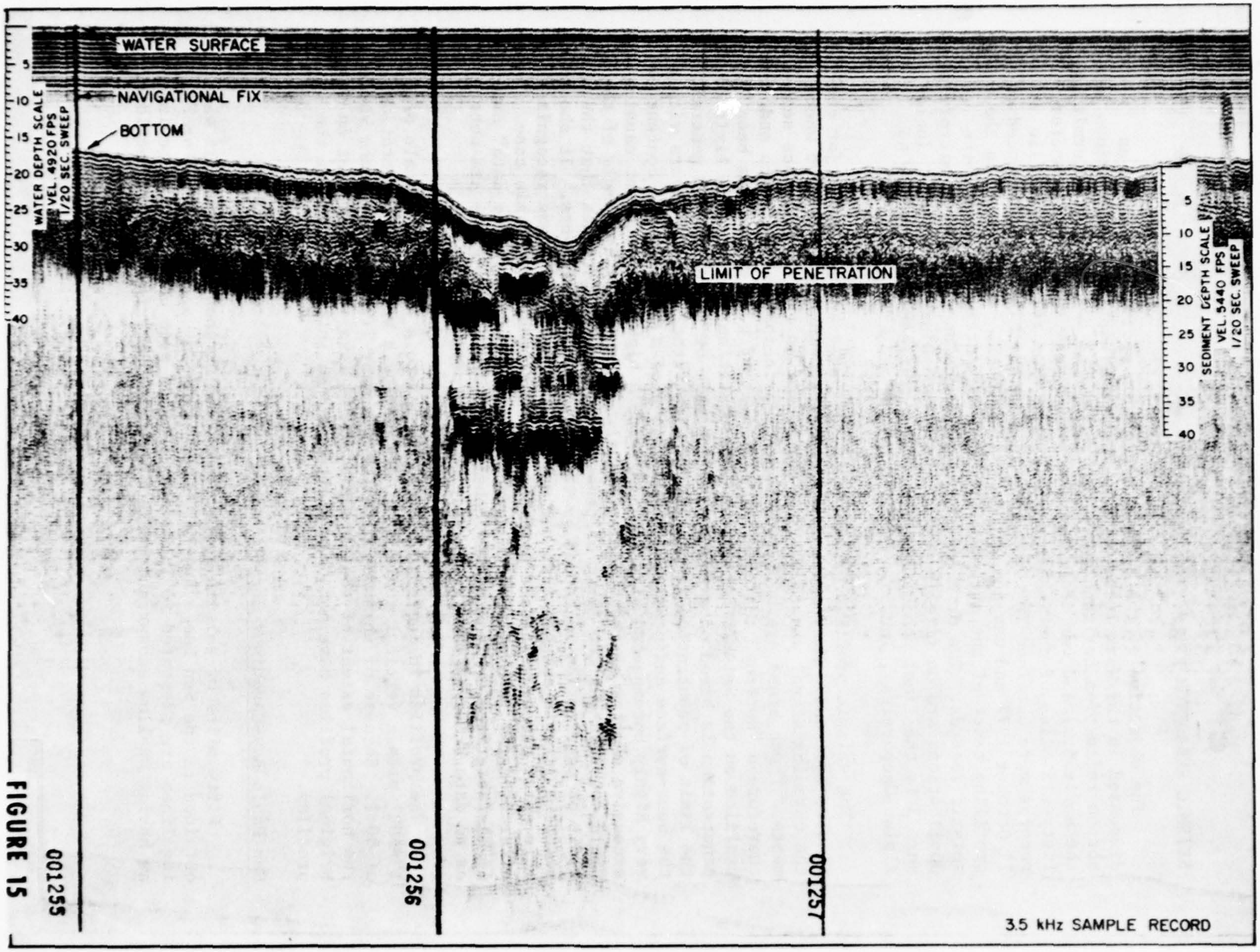

WATER SURFACE
NAVIGATIONAL FIX
BOTTOM
LIMIT OF PENETRATION
WATER DEPTH SCALE
VEL. 4920 FPS
1/20 SEC. SWEEP
SEDIMENT DEPTH SCALE
VEL. 5440 FPS
1/20 SEC. SWEEP
001255
001256
001257
3.5 kHz SAMPLE RECORD

FIGURE 15

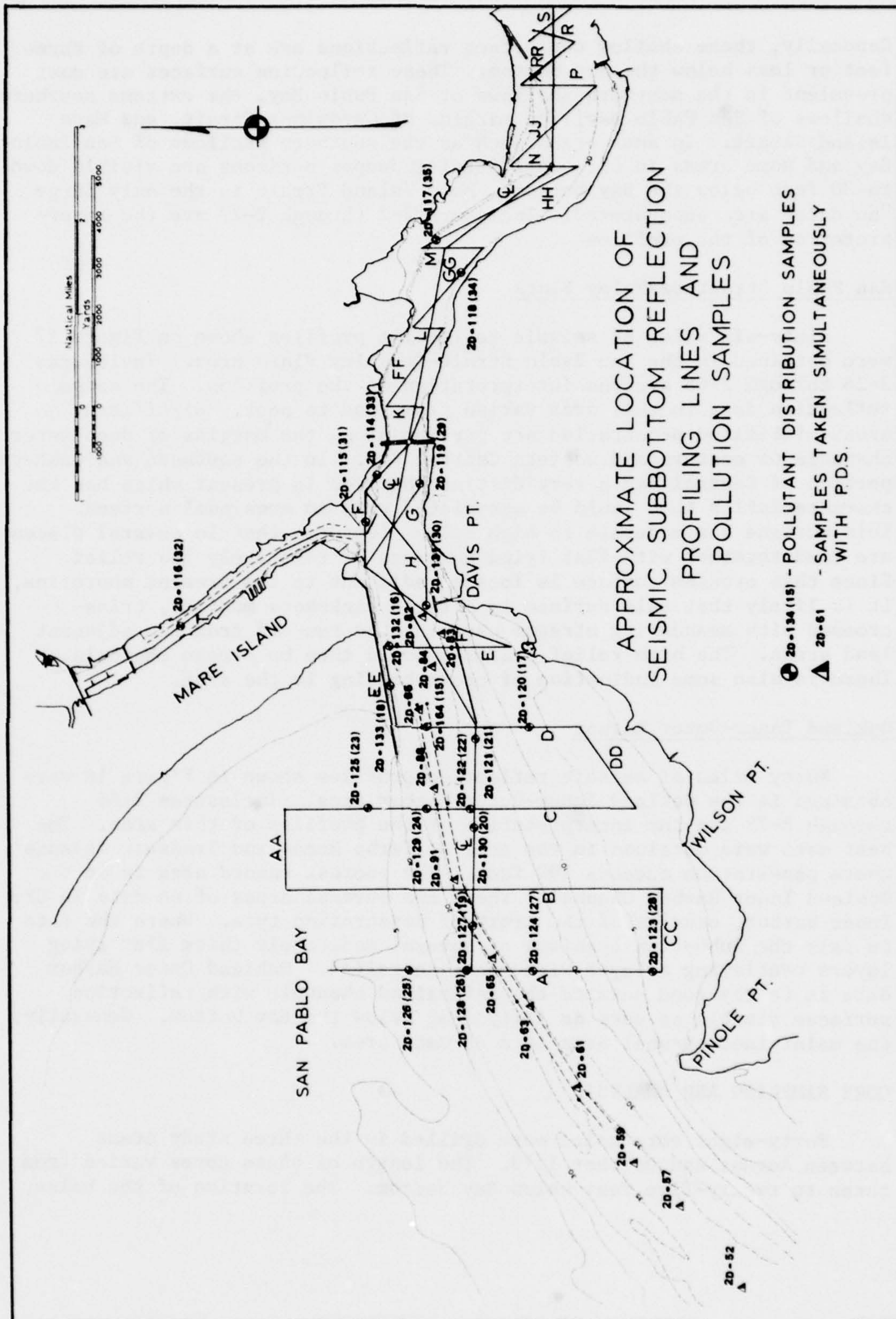

APPROXIMATE LOCATION OF
SEISMIC SUBBOTTOM REFLECTION
PROFILING LINES AND
POLLUTION SAMPLES
20-134 (15) - POLLUTANT DISTRIBUTION SAMPLES
20-61 - SAMPLES TAKEN SIMULTANEOUSLY WITH P.D.S.
SAN PABLO BAY
MARE ISLAND
DAVIS PT.
WILSON PT.
PINOLE PT.
Nautical Miles
Yards

FIGURE 16

Generally, these shallow subsurface reflections are at a depth of three feet or less below the Bay bottom. These reflection surfaces are most prevalent in the northern shallows of San Pablo Bay, the extreme southern shallows of San Pablo Bay, the margins of Carquinez Strait, and Mare Island Strait. In some areas such as the southern shallows of San Pablo Bay and some areas in Carquinez Strait, deeper horizons are visible down to 30 feet below the Bay bottom. Mare Island Strait is the only large "no data" area encountered. Inclosure 2-2 through 2-27 are the interpretation of the profiles.

San Pablo Strait-Berkeley Flats

Sixty-six miles of seismic reflection profiles shown on Figure 17 were obtained in the San Pablo Strait-Berkeley Flats area. Inclosures 2-28 through 2-65 are the interpretation of the profiles. The seismic reflection data in this area varied from good to poor. Significant areas of limited penetration are present along the margins of deep water channels of eastern and western Central Bay. In the southern and eastern portion of Central Bay a very distinct horizon is present which has the characteristics that would be associated with an erosional surface. This surface has moderate to high relief features that in several places are tied together with flat lying horizons of relatively low relief. Since this erosion surface is located adjacent to the present shoreline, it is likely that this surface is a relic backshore mudflat, criss-crossed with meandering streams carrying the run-off from the adjacent land areas. The high relief features would then be stream channels. There is also some indication of cross-bedding in the area.

Oakland Inner-Outer Harbor

Forty miles of seismic reflection profiles shown in Figure 18 were obtained in the Oakland Inner-Outer Harbor area. Inclosures 2-66 through 2-78 are the interpretation of the profiles of this area. The best data were obtained in the area of Yerba Buena and Treasure Islands where penetration exceeds 100 feet. The poorest record area is in the Oakland Inner Harbor Channel. There are several areas of no data in the Inner Harbor, usually of the limit of penetration type. Where the data is fair the subbottom consists of several moderately thick flat lying layers overlaying a layer with moderate relief. Oakland Outer Harbor data is fairly good outside the maintained channels with reflection surfaces visible as deep as fifty feet below the Bay bottom. Generally, the maintained channel area is a no data area.

CORE SAMPLING AND ANALYSIS

Forty-eight core holes were drilled in the three study areas between August and October 1973. The length of these cores varied from three to twenty-five feet below Bay bottom. The location of the holes,

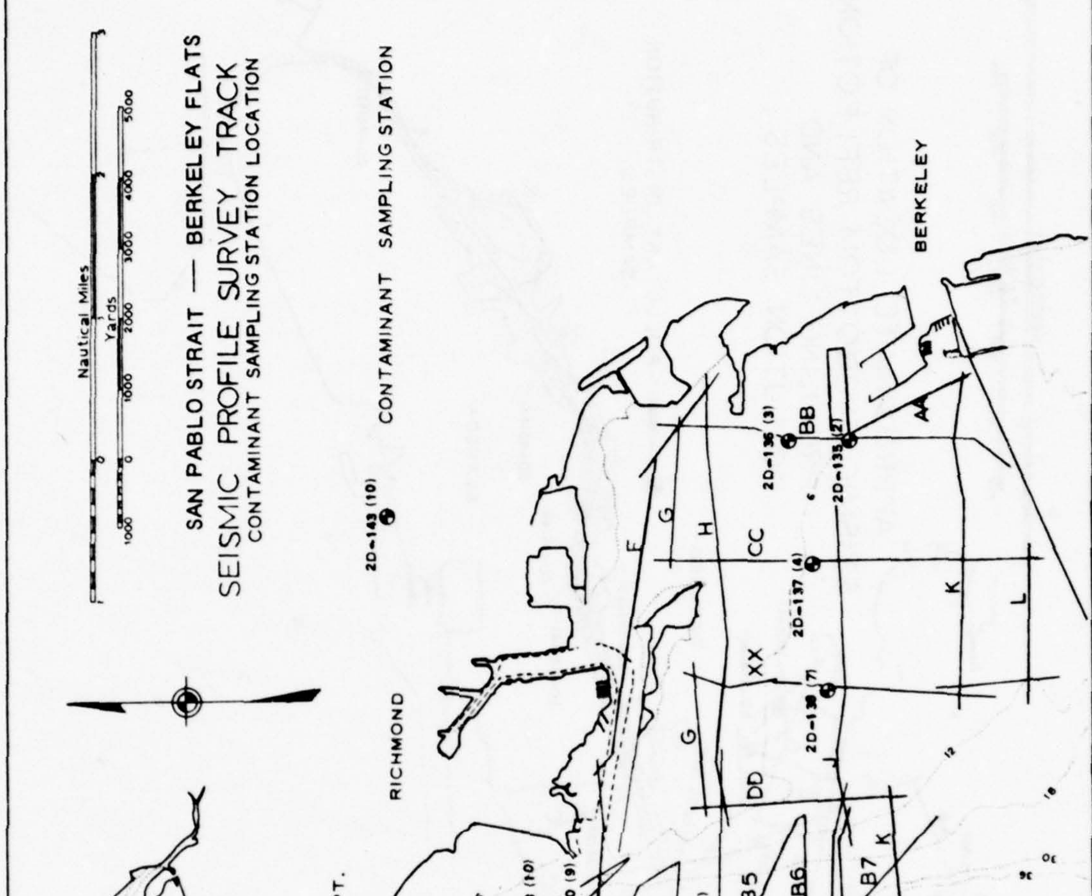

SAN PABLO STRAIT — BERKELEY FLATS
SEISMIC PROFILE SURVEY TRACK
CONTAMINANT SAMPLING STATION LOCATION
Nautical Miles
Yards
2D-143 (10)
CONTAMINANT SAMPLING STATION
PT. SAN PABLO
MOLATE PT.
CASTRO PT.
RICHMOND
BERKELEY
ANGEL ISLAND
TIBURON PENINSULA
PT. SAN QUENTIN
PARADISE CAY
SAUSALITO

FIGURE 17

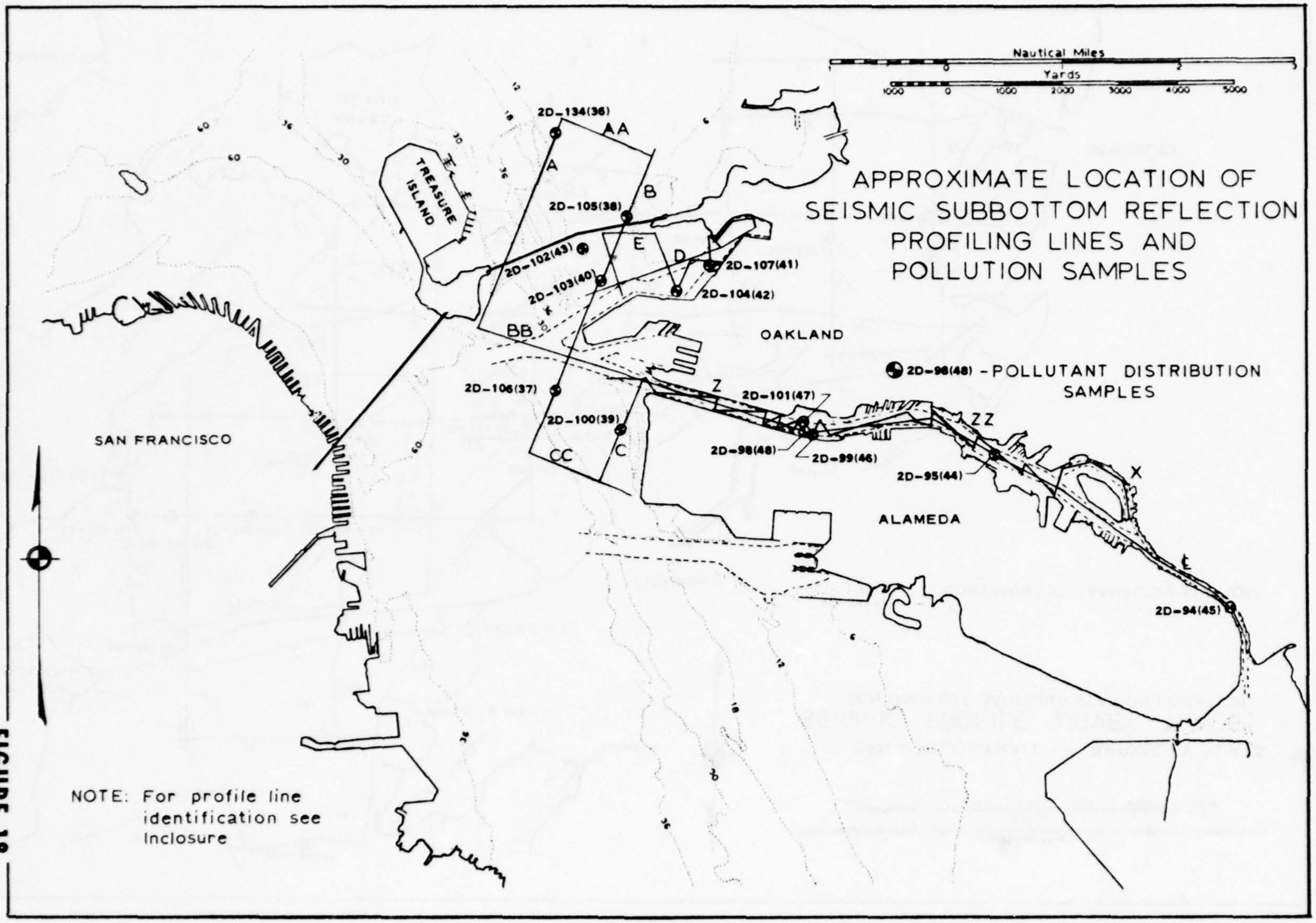

APPROXIMATE LOCATION OF
SEISMIC SUBBOTTOM REFLECTION
PROFILING LINES AND
POLLUTION SAMPLES
Nautical Miles
Yards
1000 0 1000 2000 3000 4000 5000
2D-98(48) - POLLUTANT DISTRIBUTION SAMPLES
TREASURE ISLAND
SAN FRANCISCO
OAKLAND
ALAMEDA
2D-134(36)
2D-105(38)
2D-102(43)
2D-103(40)
2D-107(41)
2D-104(42)
2D-106(37)
2D-100(39)
2D-101(47)
2D-98(48)
2D-99(46)
2D-95(44)
2D-94(45)
A
AA
B
BB
C
CC
D
E
Z
ZZ
X
NOTE: For profile line identification see Inclosure

FIGURE 18

shown in Figures 16, 17, and 18 were based on changes in the physical characteristics of bottom and subbottom sediments as shown on the seismic profile records. After delivery to the laboratory, selection of subsamples from the cores were made as discussed in the Work Items section. Pollution and mechanical analysis were performed on all subsamples. A total of 229 subsamples were analyzed for dispersed grain size distribution, lead, zinc, mercury, cadmium, copper, chemical oxygen demand, volatile solids, total Kjeldahl nitrogen, and oil and grease. The pollution analysis, particle size gradation curves and vertical distribution graphs are shown in Inclosure 4.

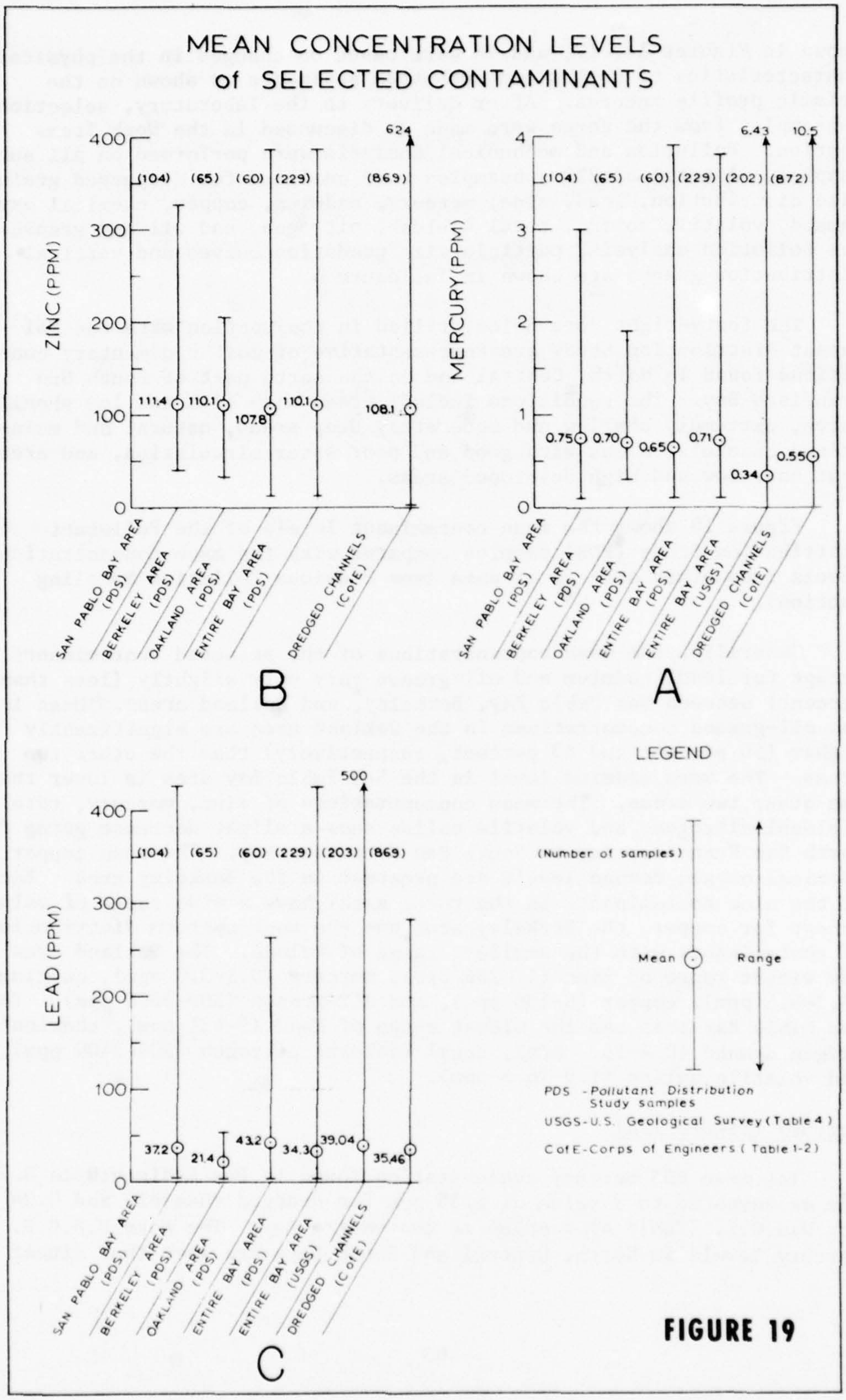
The forty-eight core holes drilled in conjunction with the Pollutant Distribution Study are representative of most sedimentary conditions found in North, Central and on the north part of South San Francisco Bay. The conditions include areas with high and low shoaling rates, extremely shallow and moderately deep areas, natural and maintained channels, areas with good and poor water circulation, and areas that have low and high developed areas.

Figure 19 shows the mean contaminant levels of the Pollutant Distribution Study (PDS) samples compared with the mean concentration levels from other sources of data (see Previous Pollution Sampling section).

Generally, the mean concentrations of the selected contaminants, except for lead, cadmium and oil-grease vary only slightly (less than 10 percent) between San Pablo Bay, Berkeley, and Oakland areas. Mean lead and oil-grease concentrations in the Oakland area are significantly higher (50 percent and 43 percent, respectively) than the other two areas. The mean cadmium level in the San Pablo Bay area is lower than the other two areas. The mean concentrations of zinc, mercury, total Kjeldahl nitrogen, and volatile solids show a slight decrease going from North San Francisco Bay to South San Francisco Bay. The mean copper and chemical oxygen demand levels are greatest in the Berkeley area. Each of the nine contaminants in the three areas have a wide range of values. Except for copper, the Berkeley area has the most uniform distribution of contaminants with the smallest range of values. The Oakland area has the widest range of zinc (17-386 ppm), mercury (0.1-3.9 ppm), cadmium (0.3-6.6 ppm), copper (6-136 ppm), and oil-grease (100-5800 ppm). The San Pablo Bay area has the widest range of lead (9-421 ppm), chemical oxygen demand (0.4-15.7 ppm), total Kjeldahl nitrogen (300-3400 ppm), and volatile solids (1.9-16.5 ppm).

<u>Mercury (Figure 19a)</u>

The mean PDS mercury concentration found in Bay sediments is 0.71 ppm as compared to a value of 0.55 ppm for dredged channels and 0.34 ppm for U.S.G.S. (Table 4) samples in the entire Bay. The mean U.S.G.S. mercury levels in North, Central and South Bays are less than either the



MEAN CONCENTRATION LEVELS
of SELECTED CONTAMINANTS
ZINC (PPM)
MERCURY (PPM)
LEAD (PPM)
(104) (65) (60) (229) (869)
624
111.4 110.1 107.8 110.1 108.1
(104) (65) (60) (229) (202) (872)
6.43 10.5
0.75 0.70 0.65 0.71 0.34 0.55
(104) (65) (60) (229) (203) (869)
500
37.2 21.4 43.2 34.3 39.04 35.46
SAN PABLO BAY AREA (PDS)
BERKELEY AREA (PDS)
OAKLAND AREA (PDS)
ENTIRE BAY AREA (PDS)
ENTIRE BAY AREA (USGS)
DREDGED CHANNELS (CofE)
B
A
C
LEGEND
(Number of samples)
Mean
Range
PDS - Pollutant Distribution Study samples
USGS - U.S. Geological Survey (Table 4)
CofE - Corps of Engineers (Table 1-2)

FIGURE 19

MEAN CONCENTRATION LEVELS of SELECTED CONTAMINANTS

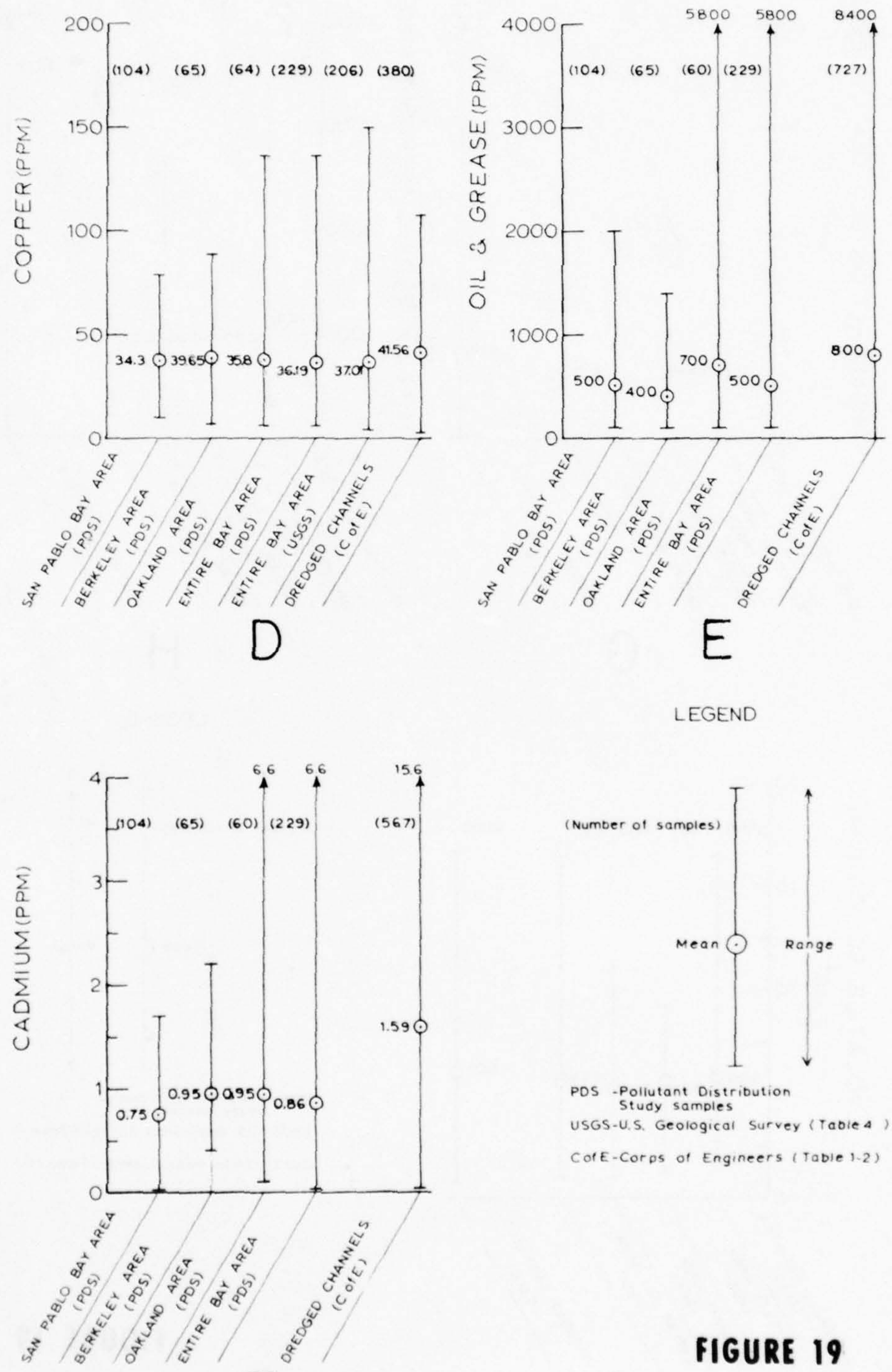


FIGURE 19 continued

MEAN CONCENTRATION LEVELS of SELECTED CONTAMINANTS

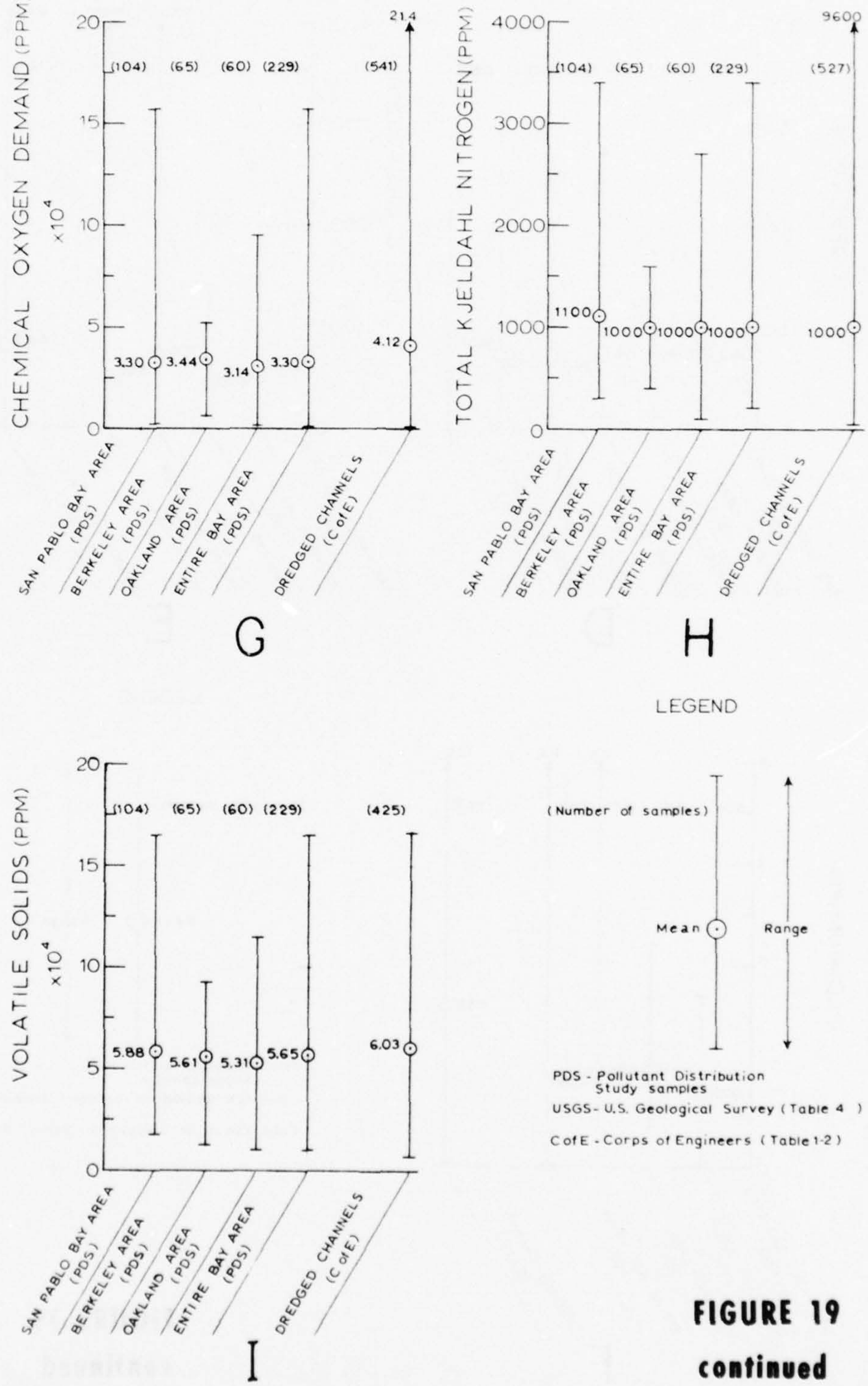


FIGURE 19
continued

PDS or dredged channels' means for the corresponding areas. The mean mercury concentrations in dredged channels of North and Central Bays are between 0.34 and 0.23 ppm less than the PDS mean concentrations in San Pablo Bay and Berkeley areas, respectively. The mean mercury level in dredged channels of South Bay (0.78 ppm) is greater than the PDS mean for the Oakland area.

Zinc (Figure 19b)

The mean PDS zinc concentration found in Bay sediments is 110.1 ppm as compared to a value of 108.1 ppm for dredged channels. The mean zinc level in dredged channels of North Bay is 126.1 ppm. In Central and South Bays the mean levels in dredged channels are 87.4 ppm and 120.0 ppm respectively. The PDS mean zinc concentrations for San Pablo Bay, Berkeley and Oakland areas are respectively 111.4 ppm, 110.1 ppm and 107.8 ppm. The PDS mean zinc levels for the Berkeley area is greater than the mean zinc concentration in dredged channels of Central Bay.

Lead (Figure 19c)

The mean PDS lead concentration found in Bay sediments is slightly smaller than the mean level in dredged channels (35.5 ppm), and the U.S.G.S. mean level for the entire Bay (39.04 ppm). The mean lead levels in dredged channels of North Bay, Central Bay and South Bay are from one to five parts per million greater than the mean PDS levels in corresponding areas. The mean U.S.G.S. lead concentration is slightly smaller than the mean PDS level in San Pablo Bay area, and 9 to 14 ppm greater than the PDS levels in Berkeley and Oakland areas, respectively. The mean lead concentration of Bradford's samples in the less than 20 micron fraction of South Bay (19.4 ppm) is substantially smaller than the other three sources of data.

Copper (Figure 19d)

The mean PDS copper concentration found in Bay sediments is 36.2 ppm. This is somewhat lower than both the U.S.G.S. mean copper level in the Bay (37.0 ppm) and the mean in dredged channels of the Bay (41.6 ppm). The mean U.S.G.S. and mean dredged channel copper concentrations for North Bay and South Bay are greater than the PDS mean levels in San Pablo Bay and Oakland areas. The mean copper level in dredged channels of North Bay (85.0 ppm) reflect only samples taken in Mare Island Strait which has exceptionally high copper levels. The mean U.S.G.S. and dredged channels' copper concentrations in Central Bay are, respectively, 5 ppm and 15 ppm greater than the PDS mean concentration for the Berkeley area. Bradford's mean copper level in the less than 20 micron sediment fraction of South Bay (41.20 ppm) is slightly greater than the PDS and mean dredged channels copper level for the South Bay and slightly smaller than the mean U.S.G.S. copper level in South Bay.

Oil and Grease (Figure 19e)

The mean PDS oil and grease concentration found in Bay sediments is 500 ppm as compared to a mean of 800 ppm in dredged channels of the Bay. The oil and grease levels in dredged channels of North Bay, Central Bay and South Bay are greater than the corresponding PDS areas.

Cadmium (Figure 19f)

The mean PDS cadmium concentration found in Bay sediments is 0.86 ppm as compared to a mean of 1.59 ppm in dredged channels of the Bay. The mean cadmium concentrations in channels of North Bay (0.54 ppm), Central Bay (1.04 ppm) and South Bay (1.84 ppm) substantially exceed the PDS means for San Pablo Bay, Berkeley and Oakland areas. Moyer, et al. investigation of cadmium in shoreline sediments of San Francisco Bay (Table 7) found a mean cadmium concentration of all shoreline samples of 1.07 ppm. The mean shoreline cadmium concentrations in North Bay (1.14 ppm) and South Bay (1.0 ppm) are greater than the PDS means for San Pablo Bay and Oakland areas, but are less than the mean concentrations in dredged channels of North Bay and South Bay. The mean shoreline cadmium concentrations of Central Bay (1.15 ppm) exceeds the mean in dredged channels of Central Bay and the PDS mean for the Berkeley area.

Chemical Oxygen Demand (Figure 19g)

The mean PDS chemical oxygen demand found in Bay sediments is 3.30×10^4 ppm. This is approximately 1×10^4 ppm less than that found in all dredged channels of the Bay. The mean chemical oxygen demand in dredged channels of North Bay (4.10×10^4 ppm), Central Bay (4.25×10^4 ppm) and South Bay (4.18×10^4 ppm) are greater than the corresponding PDS areas by approximately 1×10^4 ppm.

Total Kjeldahl Nitrogen (Figure 19h)

The mean PDS total Kjeldahl nitrogen (TKN) concentration found in Bay sediments is 1000 ppm, the same as that found in all dredged channels of the Bay. The mean TKN concentration in dredged channels of North Bay and Central Bay are 200 ppm less than the mean PDS values for San Pablo Bay and Berkeley areas. The mean TKN level in dredged channels of South Bay is 400 ppm greater than the PDS mean value for the Oakland area.

Volatile Solids (Figure 19i)

The mean PDS volatile solids concentration in sediments of the Bay is 5.65×10^4 ppm. The mean volatile solids level in dredged channels of the Bay is 6.03×10^4. The mean level in dredged channels of North Bay (6.09×10^4 ppm), Central Bay (5.82×10^4 ppm) and South Bay (6.34×10^4 ppm) are slightly greater than the means in corresponding PDS areas.

SAN PABLO BAY - CARQUINEZ STRAIT

DESCRIPTION

Carquinez Strait is the western terminus for water discharge from the Great Basin. The confluence of the San Joaquin and Sacramento Rivers is located just east of Suisun Bay where the river flow then moves into the narrow and deep Carquinez Strait. The Strait is seven and one-half miles long and varies from one-half to one mile in width. Because of the constricted width and high flows, the strait reaches depths of greater than 100 feet. The Napa River discharges into the western end of Carquinez Strait through Mare Island Strait. Carquinez Strait empties into the broad and shallow San Pablo Bay, an area where freshwater inflow from the Great Basin first becomes inter-mixed with the saline estuarine waters.

San Pablo Bay contains twenty-five percent of the total area of the Bay system. It is roughly circular and shallow, and half the bay is less than six feet deep. Much of the shoreline consists of marshes and tidal flats which are exposed at low tide. A natural channel shown in Figure 16 crosses the southern part of the bay from San Pablo Strait to Carquinez Strait. This channel is greater than 20 feet in depth. A dredged channel, maintained to a depth of 35 feet below MLLW cuts through Pinole Shoal in the eastern half of the natural channel. Another natural channel, somewhat subdued, moves north from San Pablo Strait towards the Petaluma River.

Tide and Tidal Currents

Tides in the deeper channels of northern San Francisco Bay system behave as a progressive wave with about 20 percent attenuation between the Golden Gate and Suisun Bay, due to channel friction. A time lag of tidal phase and currents occur as the tide progresses up San Francisco Bay. As a result slack current in San Pablo Bay may lag behind by one to three hours, depending in part on Delta flows. The magnitude of tidal currents in San Pablo Bay depends on the location in respect to the channels. In the channels the currents range from 4.2 knots at flood to 5.8 knots at ebb. The tidal currents in shallow areas of San Pablo Bay reach maximum velocities of about 2.5 knots. All phases of the current in Mare Island Strait occur earlier than in Carquinez Strait. On the average, flood occurs in Mare Island Strait about two hours before flood in Carquinez Strait. During this period the ebb in Carquinez Strait enters Mare Island Strait as flood. The ebb occurs in Mare Island Strait about 1.5 hours before ebb in Carquinez Strait. Current velocities in Mare Island Strait are small. Maximum ebb currents at the surface reach velocities of 1.3 knots and at the bottom

the ebb current velocities are only about 0.6 knots. Maximum flood currents reach velocities of one knot at the surface and 1.5 knots at the bottom.

Water Circulation and Mixing Characteristics

The approximate flow circulation patterns in San Pablo Bay are shown in Figure 20 for moderate freshwater inflow and typical tides. The importance of geography in dictating the circulation pattern is evident. The shallowness of the northern portion of the bay and the presence of the deeper channel through the southern sector funnels much of the flood and ebb tidal flow through that portion of the bay. Large eddy currents are developed in the shallows of the northern portion of the bay during both ebb and flood flow. Near the end of tide (Figure 20h) flood currents first enter the bay from San Pablo Strait and as the flood gathers momentum, it turns the ebb into the adjacent shallow areas, particularly in the northeast, and back into Carquinez Strait. As the flood tide progresses, the northeastern shallow area contributes flow into Carquinez Strait.

As previously discussed, much of the ebb and flood flows are concentrated in the southern portion of San Pablo Bay, due to the presence of the natural channel. However, promontories such as Point San Pablo and Pinole Point generate small gyres (whirls) in the extreme southern portion of the bay.

Current flow in Carquinez Strait is primarily bi-directional with the major concentration being in the deeper channel section. Along the periphery of the strait current velocities are greatly subdued with the formation of small, low velocity eddies in areas where the cross-section area becomes larger.

Tidal circulation in Mare Island Strait is primarily bi-directional. There exists a bottom flood predominance with the tidal prism filling largely through the bottom waters and a surface ebb predominance with the tidal prism emptying in the surface waters.

San Pablo Bay is well mixed for most river inflows and partly mixed during periods of storm runoff (freshet condition). During high runoff there is a tendency toward stratified flow in the channels. Carquinez Strait and Mare Island Strait are well mixed for low and intermediate river discharges, but portions may range from partly mixed to nearly freshwater throughout during periods of high runoff.

Wind and Wave Action

Prevailing westerly winds occur in the San Pablo Bay area during much of the spring and throughout the summer. Hills near the western

FLOW CIRCULATION IN SAN PABLO BAY

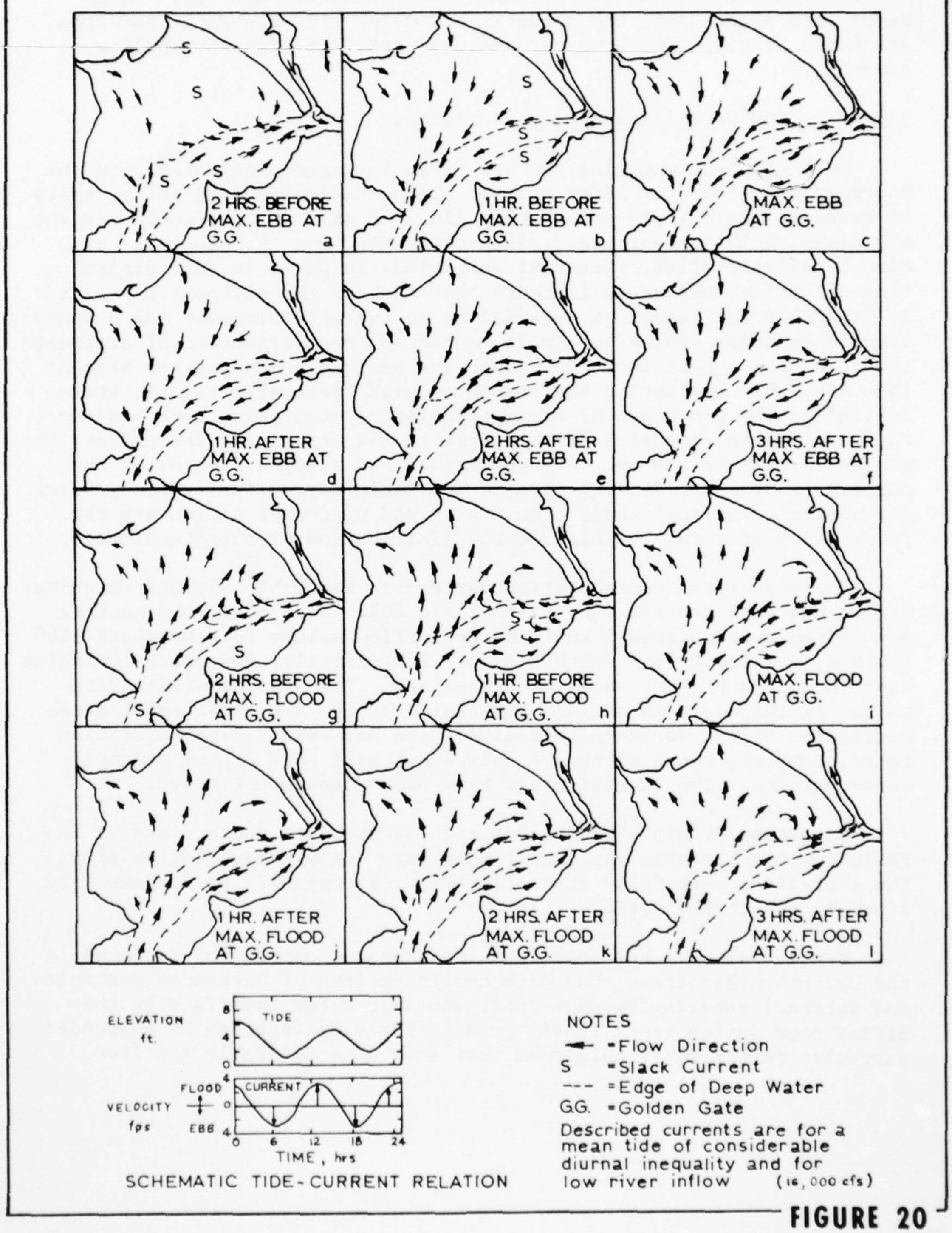


FIGURE 20

shore of the Bay shelter the adjacent shallow water from the full effect of prevailing westerlies. The long fetch for westerly winds allows sizable waves up to five feet in height to occur over the extensive shallow area in the northeastern portion of the bay. Large waves also occur along the channel, often entering San Pablo Bay from San Pablo Strait. These waves move eastward into adjacent shallow areas.

Sediments and Depositional Characteristics

Most sediment entering the San Pablo Bay area originates from the Sacramento-San Joaquin River system. These sediments like the majority of those in the Bay are principally clay and silt. About 40-60 percent are clays, 5-10 percent are organic materials, and the remainder are almost entirely silts. Seasonal variations in particle size distribution of surface sediments indicate that much of the sediment deposited in San Pablo Bay cannot be regarded as permanently placed. The estuary's dynamic behavior causes an almost continuous redistribution of sediments after initial deposition. Suspended and bedload sediments are brought into San Pablo Bay during the season of high freshwater runoff, where, initially, the processes of transportation, flocculation, and sedimentation allow an extensive distribution of new deposits. Thereafter, the processes of resuspension, transportation and redeposition alter the pattern of sediment distribution in San Pablo Bay. Tidal action, water circulation, internal shear from mixing and wind-wave action are the principal forces responsible for the distribution of these sediments.

The historical sedimentation pattern in San Pablo Bay and Carquinez Strait has been described by Smith (Ref. 20). Figure 21 is a contour map of the average annual sediment deposition volume for the years 1860 to 1956, developed from Smith's data. Historically, the channel margins have shown the highest rates of deposition. The shallow areas lying mostly in the northern and western limits of the Bay, with small areas contiguous to the southern shoreline, have had fairly high deposition rates; however, these rates are only about half that of the channel areas margins. The channel areas have shown consistent scour.

Carquinez Strait like channel and intermediate depth areas in San Pablo Bay has historically experienced very heavy sedimentation along the shoreline, especially the north shore, accompanied by compensating scour in the channel area.

Krone (Ref. 21) has described the seasonal deposition patterns in the San Pablo Bay area. The high concentrations of suspended particles and internal shearing between fresh and salt water interface in the mixing zone during storm runoff promote rapid aggregation of suspended particles in the water column as they move into San Pablo Bay from

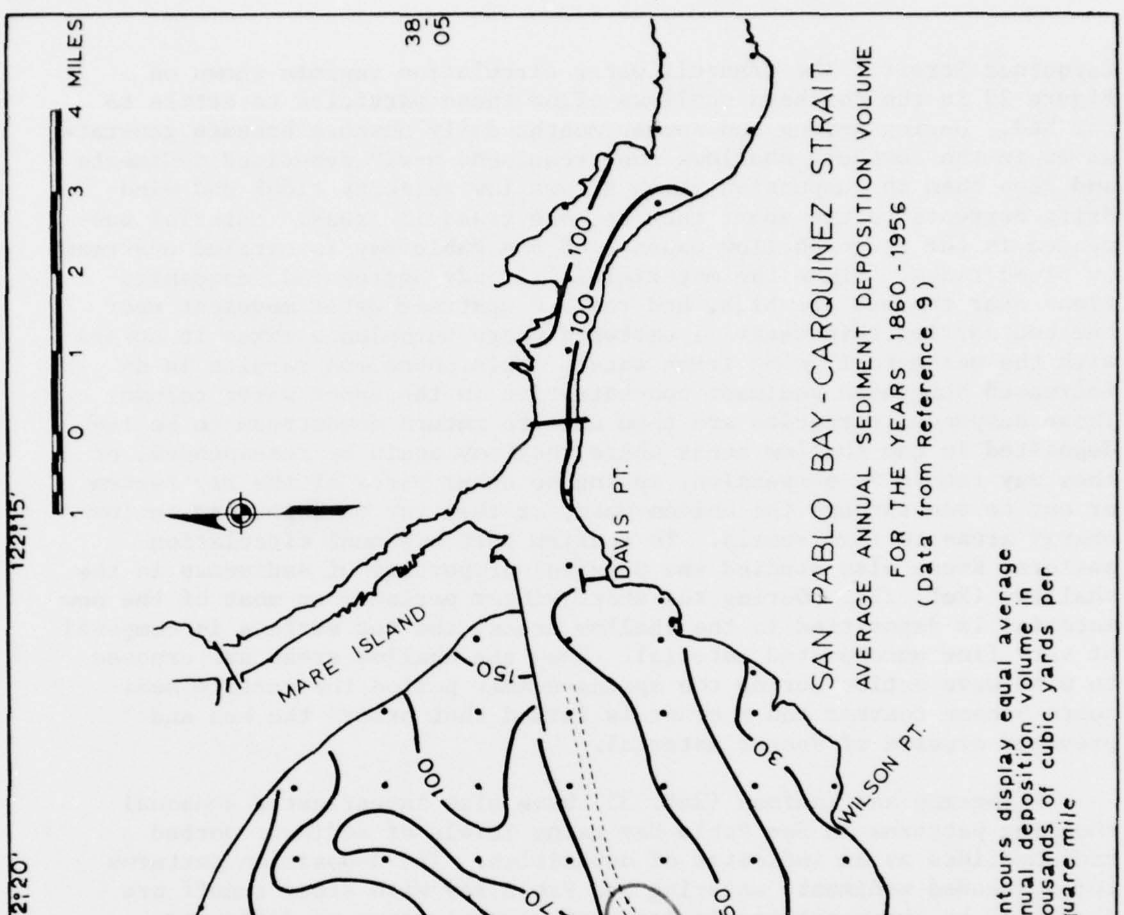

SAN PABLO BAY - CARQUINEZ STRAIT
AVERAGE ANNUAL SEDIMENT DEPOSITION VOLUME
FOR THE YEARS 1860 - 1956
(Data from Reference 9)
NOTE: Contours display equal average annual deposition volume in thousands of cubic yards per square mile
0 1 2 3 4 MILES
122°15'
122°20'
122°25'
38° 05'
38° 00'
MARE ISLAND
DAVIS PT.
WILSON PT.
PINOLE PT.
PT. SAN PEDRO
150
100
70
50
30
10
0

FIGURE 21

Carquinez Strait. The tranquil water circulation regimen shown on Figure 20 in the northern shallows allow these particles to settle to the bed. During spring and summer months daily onshore breezes generate waves in the northern shallows that resuspend newly deposited sediments and keep them in suspension which allows low velocity tidal and wind drift currents to transport them to more tranquil areas. Material suspended in the large shallow expanse of San Pablo Bay is carried upstream by flood tides. Since the material is already aggregated, concentrations near the bed are high, and the net upstream water movement near the bed carries this material eastward where turbulence mixes it upward with the westward flowing fresh water. This phenomena results in an increased suspended sediment concentration in the upper water column. These suspended particles are then able to return downstream to be redeposited in the shallow areas where they may again be resuspended, or they may remain in suspension, moving to other parts of the Bay system or out to sea through the Golden Gate, or they may be deposited in low energy areas to form shoals. To confirm this sediment circulation pattern, Krone also studied the physical properties of sediments in the shallows (Ref. 22). During the short winter period when most of the new material is depositied in the shallow areas, the bed surface is composed of very fine uncompacted material. When the shallow areas are exposed to wind-wave action during the spring-summer period the surface sediments become coarser and a crust is formed that armors the bed and prevents erosion of deeper material.

Klingeman and Kaufman (Ref. 35) have also investigated seasonal shoaling patterns in San Pablo Bay using levels of sediment sorbed radionuclides as an indicater of deposition. The deposition patterns for suspended sediments entering San Pablo Bay with storm runoff are described by these authors in terms of several zones of differing deposition characteristics. They found that initial deposition of sediments from storm runoff occurs along the dredged channel (Pinole Shoal channel) and on the north and south side of the dredged channel. After initial deposition, an almost continuous interchange occurs between suspended and deposited sediment over much of San Pablo Bay due to wind-wave action in the spring-summer period. The effectiveness of this mechanism diminishes with increasing depth and depends upon location and exposure to waves. The shallow portions of San Pablo Bay, which appear to be in a long-term quasi-equilibrium state with only a very gradual loss of depth, go through a short period of bed aggradation during the winter and a long period of less intense bed erosion during the spring-summer. In the northern shallow region sediment resuspension can take place soon after initial deposition. This area is a sediment reservoir providing long-term supply of sediment for secondary deposition in other parts of the estuarine system, particularly in deeper water near the channel. The second zone, typified by the southern shallows east of Pinole Point, is also subject to resuspension losses of initial deposits

by wind-wave aggitation. However, a greater degree of protection against wind-wave resuspension is provided by the shoreline and by the orientation of this area with respect to the direction of strong prevailing winds. Consequently, secondary depositon of sediment removed from the northern shallows may be large in this southern shoal region under suitable conditions. The shallow areas along the western and southwestern shore of San Pablo Bay are probably intermediate in their deposition behavior between that of the northern and southern shallows. Secondary deposition of sediment from the northern shallows is likely because of the pattern of current circulation and waves traveling into the bay from San Pablo Strait.

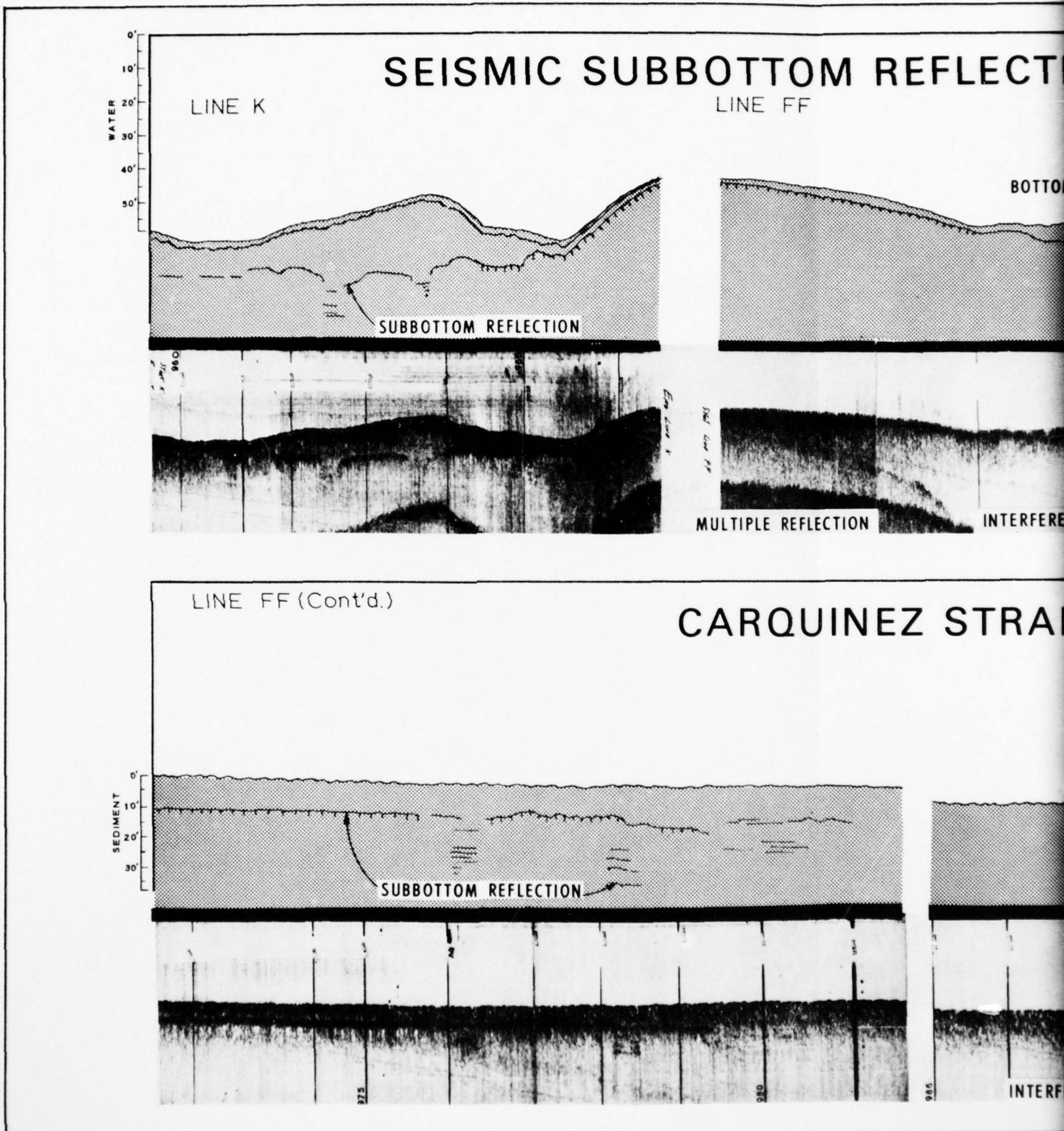
Since the establishment of the Mare Island Naval Shipyard in 1854, Mare Island Strait channel has experienced extremely high rates of shoaling requiring a large amount of maintenance dredging to maintain the channel to a project depth of 32 feet. The average annual quantity of dredged sediment is approximately 2.2 million cubic yards. The high cost of maintaining the channel has resulted in many studies of the shoaling problem. Krone (Refs. 21 and 22) has conducted extensive studies in Mare Island Strait. He reported that even though most sediment is brought into the San Pablo Bay area during storm runoff, the principle shoaling period in Mare Island Strait is during the spring and summer months when the tidal flood currents bring the resuspended sediments from San Pablo Bay back into Carquinez Strait. The tidal phase lag and bottom flood predominance in Mare Island Strait allows high sediment laden water to enter the Strait and subsequently be trapped due to the surface ebb predominance (Ref. 3).

SEISMIC SUBBOTTOM REFLECTION PROFILING

Figure 22 is a seismic subbottom cross-section of Carquinez Strait. In the shallows along both margins of Carquinez Strait only one shallow subbottom reflection surface is discernible. In deeper depths at mid-channel sand waves are prevalent along much of the length of the strait.

The entire length of the Mare Island Strait channel is typically an area of limited penetration or an area of no return.

Figures 23 and 24 are typical seismic subbottom cross-sections of San Pablo Bay. These cross-sections are lines A and B. These figures indicate the presence of two deposition provinces in San Pablo Bay. The first province, represented on the seismic reflection profile lines as an area with numerous distinguishable subbottom reflection surfaces, is located in the southern portion of San Pablo Bay. This area includes the southern shallows, Pinole Shoal Channel and a narrow band on the north side of Pinole Shoal Channel. Logs of borings and mechanical analysis of sediments show that the numerous seismic reflection surfaces


SEISMIC SUBBOTTOM REFLECT
LINE K
LINE FF
WATER
0'
10'
20'
30'
40'
50'
BOTTO
SUBBOTTOM REFLECTION
960
MULTIPLE REFLECTION
INTERFERE
LINE FF (Cont'd.)
CARQUINEZ STRAI
SEDIMENT
0'
10'
20'
30'
SUBBOTTOM REFLECTION
975
980
985
INTERFE

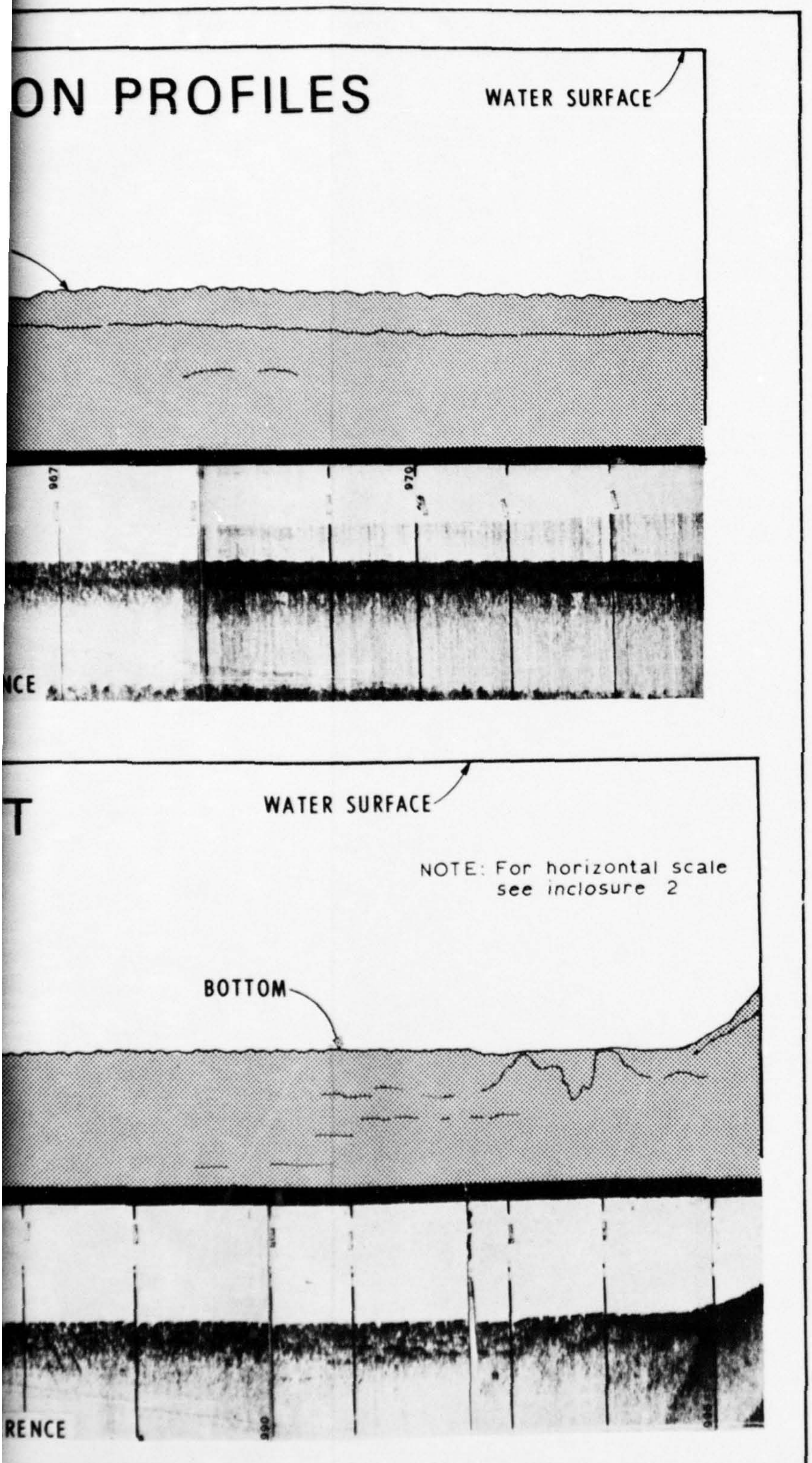
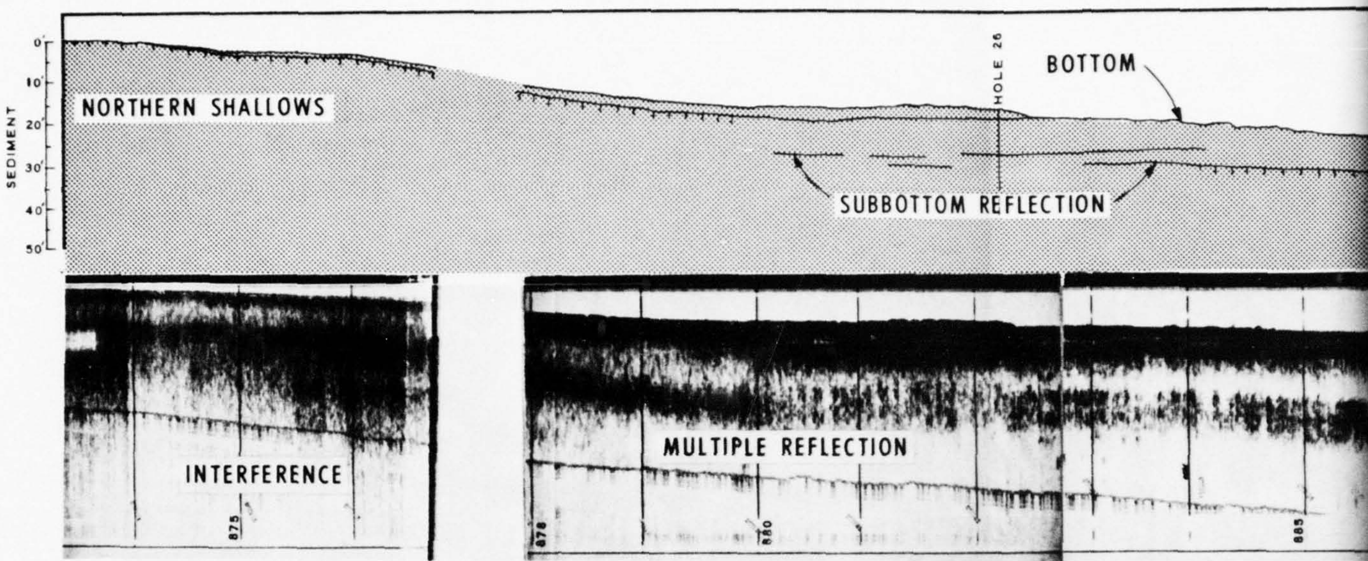

ON PROFILES
WATER SURFACE
NCE
T
WATER SURFACE
NOTE: For horizontal scale
see inclosure 2
BOTTOM
RENCE

FIGURE 22

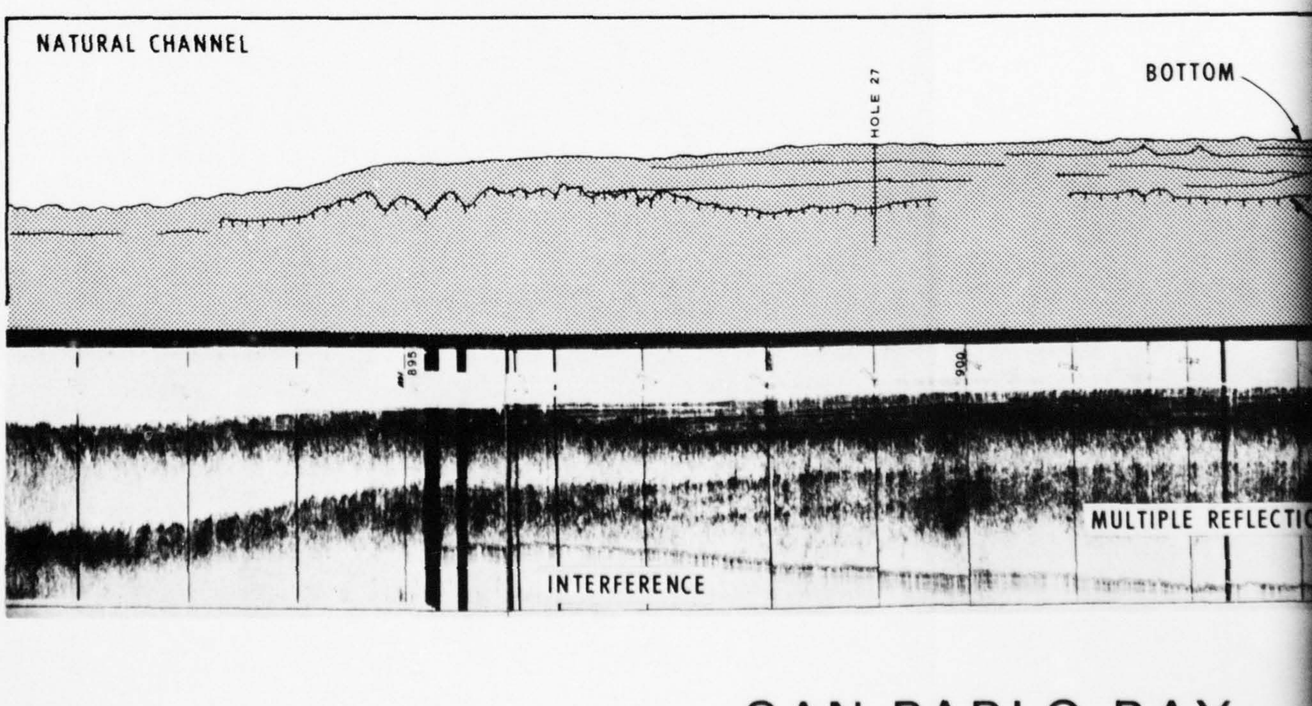
2

SEISMIC SUBBOTTOM REFLECTIO

LINE A

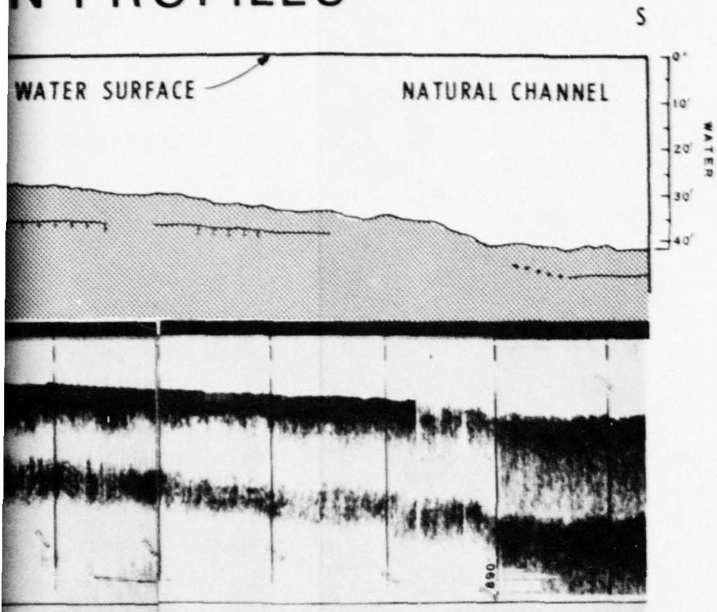


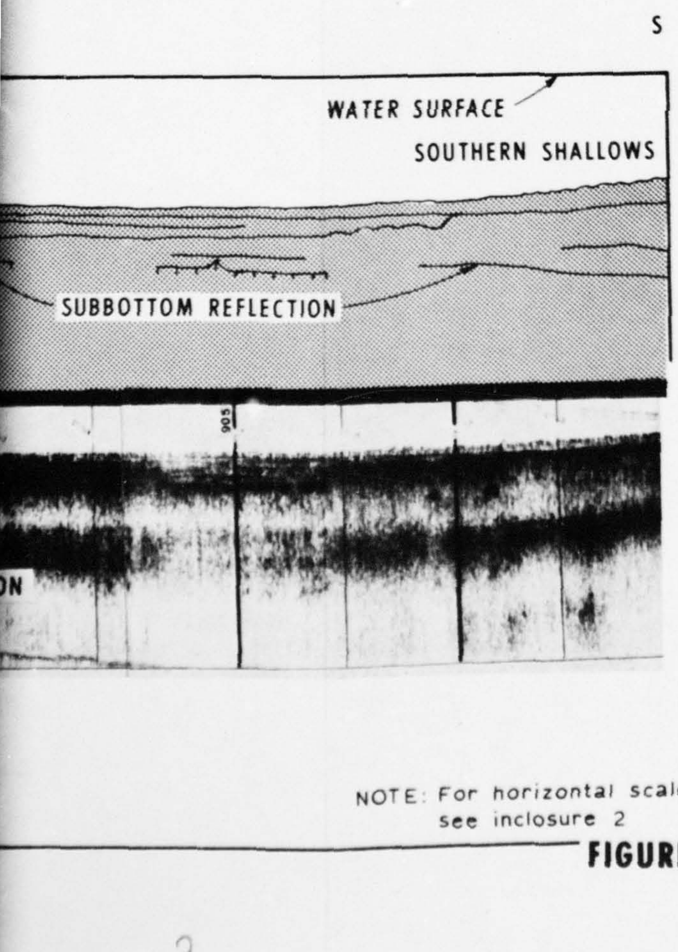
N LINE A (Cont'd.)



SAN PABLO BAY

N PROFILES





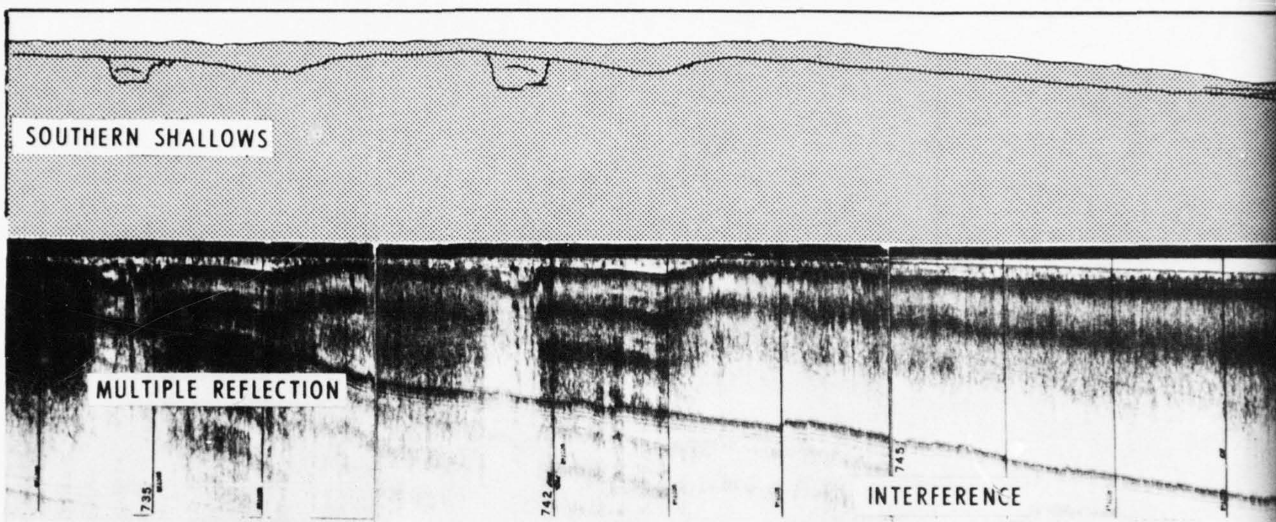
NOTE: For horizontal scale
see inclosure 2

FIGURE 23

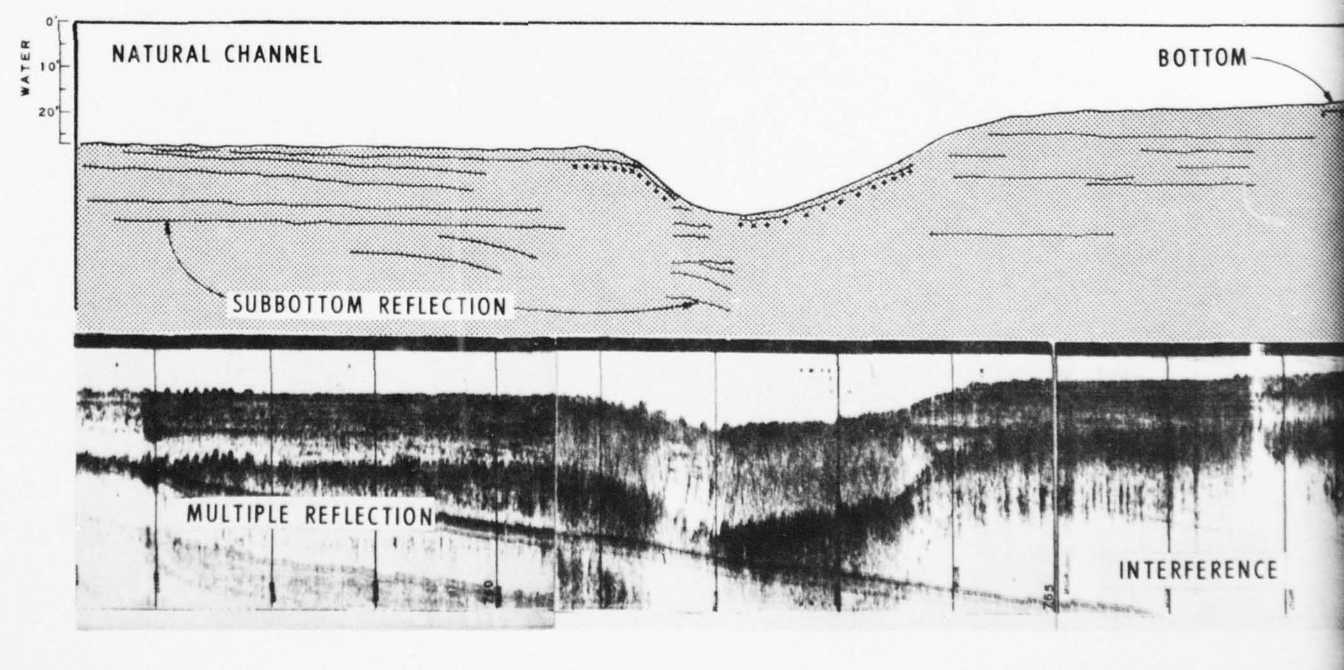
2

SEISMIC SUBBOTTOM REFLECTION

S LINE B

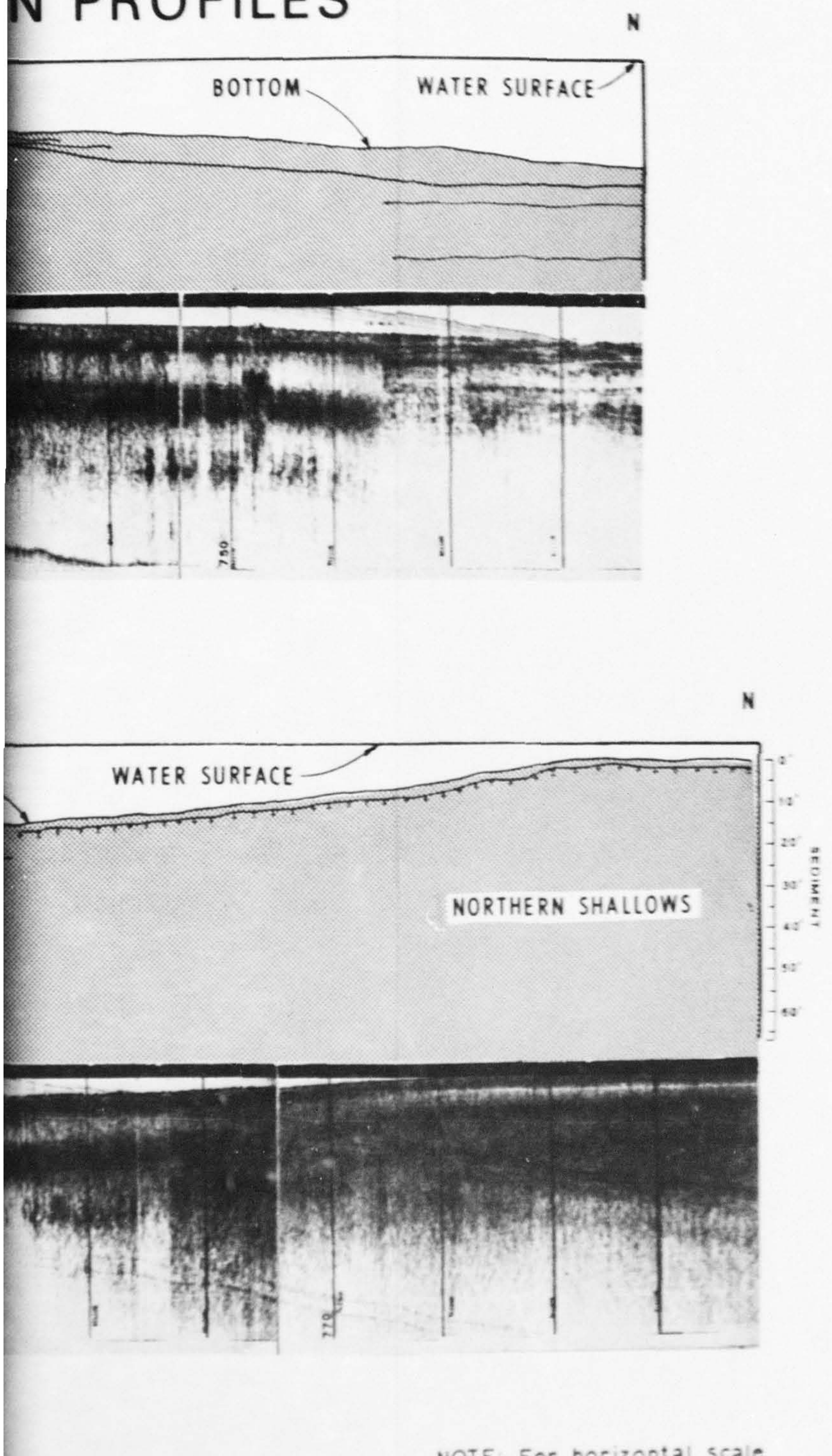


S LINE B (Cont'd.)



SAN PABLO BAY

N PROFILES



NOTE: For horizontal scale
see inclosure 2

FIGURE 24

AD-A071 722 CORPS OF ENGINEERS SAN FRANCISCO CALIF SAN FRANCISCO--ETC F/G 13/3
DREDGE DISPOSAL STUDY. SAN FRANCISCO BAY AND ESTUARY. APPENDIX --ETC(U)
MAY 79 R M ECKER, J F SUSTAR, J HENDRICKS

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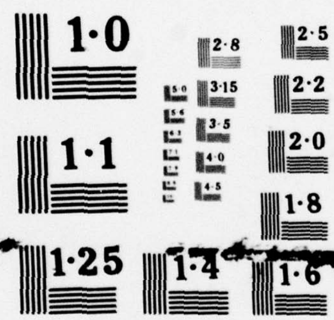


NATIONAL BUREAU OF STANDARDS

are alternating layers of clayey silt, silty sand. These horizons vary in thickness from less than two feet to greater than six feet. In many cases sand lenses and numerous shell fragments are found at various depths. Inclosure 4-32 is the particle size gradation curves for Hole 2D-124 (27), representing five samples from the depths 28 to 50.5 feet below MLLW. The particle size distributions are typical of sediments in this province. The median particle size within horizons vary from 1.5 microns to 250 microns. The surface sediments are normally within the finer particle size ranges.

The second deposition province, located in the northern shallows of San Pablo Bay, is characterized on the seismic reflection profiles as an area of limited penetration. Without exception the seismic signal is attenuated in the first two to three feet of bottom sediment. As discussed previously, an area of limited penetration is indicative of high organic content or very loosely compacted silts and clays. Logs of borings and mechanical analysis of sediments in this province indicate that to the depth that borings were taken, the sediments are very uniformly distributed black to gray clayey silt and silty clay having a high organic content and very uncompacted. Inclosure 4-29 is the particle size gradation for Hole 2D-126 (25) representing depths from 7 to 24.5 feet below MLLW. The median particle size for the samples in the northern shallows range from 1.5 microns to 2.0 microns. When compared with Hole 2D-124 (27) it is apparent that the sediments in the northern shallows are generally finer than those in the southern portion of San Pablo Bay and that the sediments are uniformly distributed with depth, having only a slight range in particle sizes.

The boundary of the two deposition provinces runs parallel to Pinole Shoal Channel and can be defined as the northern edge of the natural channel running through the southern portion of San Pablo Bay. The interface lies in water depths between 15 and 20 feet below MLLW.

Because of the depth of deposits and spatial extent of the two deposition provinces in San Pablo Bay, they may be described as separate geomorphologic provinces whose histories of deposition have differed substantially within the recent geologic time frame represented by the seismic subbottom reflection profiles and core samples. The northern shallows province is a region where deposition forces have caused a uniform spatial and temporal distribution of sediments. The net effect of these forces, primarily wind-wave action, has been a continuous mixing of the fine sediments. The homogeneous deposits indicate the absence of strong currents and the abundance of fine suspended sediment. The only distinguishing physical characteristics of the sediment in this province are a slight increase in compactness with depth due to the weight of overlying sediments and a change in color from brownish-gray at the surface to black at depth due to the change in the oxidation-reduction state of the sediments. To have the uniformly distributed

deposits that exist in the northern shallows there must be a continuous interchange of existing deposits with new deposits being delivered into the northern shallows. The lack of stratification indicates that, historically, deposition has taken place above the wave base and that this process has been continuous. Evidence of changes in sediment texture, size distribution or mineralology is destroyed by the ever present wind-wave action working the fresh sediments shortly after deposition.

The alternating layers of clayey silt and silty sand in the southern San Pablo Bay deposition province is indicative of a non-turbulent or intermittently turbulent environment of deposition. In a non-turbulent environment, deposition continuously takes place below the depth of effective wave action, whereas in an intermittently turbulent environment deposition occurs intermittently above and below the wave base. Current action becomes the primary force in determining deposition and erosion. The periodic absence of wave action allows the stratified nature of the sediments to remain intact and disturbances to deposits by current action is seldom great enough to cause vertical mixing of deposits.

The depth of effective wave action (wave base) is dependent on the predominate wave height and period. Wave height and period in turn are determined by the effective fetch length, duration and intensity of the generating force (wind) and water depth. The northern shallows with its long fetch length, prevailing westerly winds and shallow depths is subject to the greatest wave energy in San Pablo Bay. The southern part of San Pablo Bay consists of both shallow and deep areas. The deep areas in and adjacent to the natural channel appear to be below wave base for the predominate wave conditions in San Pablo Bay. The effective depth of wave action can be approximated by the boundary separating the northern shallows and the natural channel at a depth between 15 and 20 feet. The southern shallows, although in very shallow water, can be considered an intermittently turbulent deposition environment because the short fetch length for prevailing westerly winds does not allow large waves to be generated in that area.

CORE SAMPLING AND ANALYSIS

Twenty-one holes varying in depth from nine to 22 feet below Bay bottom shown in Figure 16 and Inclosure 4 were drilled in the San Pablo Bay-Carquinez Strait area. Three to six samples from each core were analyzed for particle size distribution and the nine contaminants. The following sections are concerned with the physical (size distribution) and chemical (pollutional) characteristics of these sediments.

Physical Sedimentary Characteristics

Size characteristics of sedimentary deposits in the San Pablo Bay-Carquinez Strait area vary greatly both vertically within holes and laterally between holes. The sediments range from silty clay with less

than one percent sand that are uniformly distributed with depth to alternating layers of clayey silt and silty sand. The vertical distribution of the sediments reflects the historical variation in the environment of deposition. The environment of deposition is determined by the physical factors discussed previously, e.g., tide and tidal currents, water circulation and mixing characteristics, and wind-wave action. Where the sediments are found to be uniformly distributed with depth the environment of deposition has necessarily been continuous throughout the history of the deposition. Conversely, where the sediments exhibit a heterogeneous distribution the environment of deposition has not been continuous. The changing environment of deposition is reflected by the vertical changes in the character of the sedimentary deposits. Furthermore, the relative magnitude (energy input) of the physical factors that make up the environment of deposition may be determined by the size and distribution characteristics of the sediments. Thus, uniformly distributed fine sedimentary deposits indicate a continual low transporting energy environment, whereas a continuous high transporting energy environment would result in uniformly distributed coarse sediments. Table 8 is a listing of mean hole clay and sand content in order of decreasing clay percentages of the core samples taken in the San Pablo Bay-Carquinez Strait area. The mean hole clay and sand content indicates the relative magnitude of the environment of deposition during the history of deposition. The deviation from the mean indicates the degree of uniformity or heterogeneity of deposits and, thus, the relative changes in the input energy (environment of deposition) during the history of deposition. Where the standard deviation from the mean is small, the sediments are uniformly distributed with depth. Where there is a large standard deviation the sediments are non-uniformly distributed with depth, indicating stratification of the sediments.

The finest sediments in the San Pablo Bay-Carquinez Strait area are found at 2D-116(32) in Mare Island Strait, and 2D-125(23) and 2D-126(25) in the northern shallows of San Pablo Bay. The mean sand content in these three holes is less than two percent and the clay content varies from 49 to 53 percent. These extremely fine sediments are uniformly distributed with depth as is indicated by their small standard deviations.

Sediments on the north channel margins of Carquinez Strait to the east of the entrance to Mare Island Strait are generally fine with the mean hole clay content varying from 32 ± 11 percent to 40 ± 3 percent. The sand content of holes in this area is greater than in the northern shallows and Mare Island Strait, varying from 9 ± 2 percent to 15 ± 21 percent. The sediments are also less uniformly distributed with depth, varying from clayey silt to silty sand clay. The coarser material is found in the surface sediments of 2D-114(33) and 2D-115(31), near the entrance to Mare Island Strait.

Hole 2D-123(28) located on the west end of the southern shallows of San Pablo Bay is comprised of sediments similar to those of the north channel margins of Carquinez Strait. The mean clay and sand contents are 36±11 percent and 8±11 percent, respectively. The large deviation from the mean sand content is due to the presence of one five-foot thick sandy silt layer between 5 and 10 feet below Bay bottom. The sand content in the remainder of the hole is negligible.

The sediments of the south channel margins of Carquinez Strait are much coarser than the north channel margins. The sediments range from sand to silty sand and sand-silt-clay material. The mean hole clay content of the two holes in this area, 2D-118(34) and 2D-119(29), is less than 20 percent and the mean hole sand content is greater than 40 percent.

The most randomly distributed sediments with depth indicated by the large deviation from the mean hole and sand contents in Table 8 are found on the west end of the natural channel, entrance to Carquinez Strait, and the southern margin of the natural channel in San Pablo Bay. The mean hole sand content at these locations vary from 32 percent to 56 percent. Hole 2D-131(30) on the south side of Carquinez Strait, as an example, has a sand content varying from 67 percent at the surface to 7 percent at seven feet below Bay bottom. In contrast, holes 2D-124(27) and 2D-128(26) along the west end of the natural channel are comprised of a relatively thin layer of clayey silt at the surface and thick beds of silty sand at depth. The sand content of these two holes vary from less than 2 percent in the surface sediments to greater than 50 percent at depth. Hole 2D-121(21) located on the south channel margin is comprised of one thick clayey silt bed in the upper ten feet of sediment and a thick silty sand layer below 10 feet.

Hole 2D-120(17) at the east end of the southern shallows is comprised of alternating layers of clayey silt and silty sand. The sand content varies from 11 to 48 percent. In comparison to 2D-123(28) at the west end of the southern shallows, the sediments of 2D-120(17) are much coarser and more randomly distributed.

TABLE 8

SAN PABLO BAY-CARQUINEZ STRAIT
MEAN HOLE SAND AND CLAY CONTENT

	Hole	Location	Clay $<2\,\mu$ %	Sand $>74\,\mu$ %
1.	2D-126(25)	Northern Shallows	53±4	1±1
2.	2D-125(23)	Northern Shallows	53±3	2±1
3.	2D-116(32)	Mare Island Strait	49±3	1±1
4.	2D-115(31)	North Side Carquinez Strait	40±3	15±21
5.	2D-114(33)	North Side Carquinez Strait	36±8	15±11
6.	2D-123(28)	Southern Shallows	36±11	8±14
7.	2D-117(35)	North Side Carquinez Strait	32±11	9±2
8.	2D-124(27)	West End Natural Channel	30±18	34±34
9.	2D-131(30)	Entrance to Carquinez	27±14	32±33
10.	2D-121(21)	Margin Natural Channel	26±16	39±33
11.	2D-128(26)	West End Natural Channel	24±11	37±25
12.	2D-121(17)	Southern Shallows	24±7	28±16
13.	2D-132(16)	Entrance to Carquinez	21±13	56±32
14.	2D-127(19)	Maintained Channel	19±5	54±16
15.	2D-119(29)	South Side of Carquinez	19±10	47±23
16.	2D-118(34)	South Side of Carquinez	17±6	44±17
17.	2D-122(22)	Natural Channel	15±8	60±20
18.	2D-133(18)	Entrance to Carquinez	14±8	69±15
19.	2D-164(15)	Maintained Channel	12±5	62±14
20.	2D-129(24)	Natural Channel	11±7	70±17
21.	2D-130(20)	Natural Channel	10±7	73±17

NOTE: The value after the ± sign indicates one standard deviation from the mean.

The sediments at the east end of the natural and maintained navigation channel are the most uniformly distributed coarse sediments found the San Pablo Bay-Carquinez Strait area. Except for a very few individual samples the sand content in the sediments is greater than 50 percent. The mean hole sand content varies from 60 to 70 percent and the deviations from the mean are less than 30 percent.

Distribution of Contaminants in Surface Sediments

Contaminants in surface sediments represent the most recent input into the system, whether it be from discharges, street runoff, upland erosion or reworking (resuspension and deposition) of contaminants in existing sediment deposits. The distribution of contaminants in the surface sediment will best portray the existing distributing forces in the system.

The surface sediments of the San Pablo Bay-Carquinez Strait area are enriched with most of the nine contaminants. Table 9 is a comparison of the mean contaminant levels in the surface sediments (0-0.6 feet) with sediments greater than 0.6 feet deep. On the average levels of volatile solids, chemical oxygen demand, and total Kjeldahl nitrogen vary only slightly with depth, whereas the levels of the trace metals and oil-grease in the surface sediments exceed the levels at deeper depths by 20 to 40 percent.

TABLE 9

MEAN CONCENTRATION OF CONTAMINANTS IN SURFACE AND DEEPER SEDIMENTS IN SAN PABLO BAY-CARQUINEZ STRAIT AREA

Parameter	Mean Concentration (ppm) 0-0.6 Feet	Mean Concentration (ppm) Greater Than 0.6 Feet	% Greater Than
Lead	57.50	32.70	43
Zinc	135.00	105.80	22
Mercury	1.07	0.68	37
Cadmium	0.89	0.72	19
Copper	41.10	33.00	20
Oil-Grease	700.00	450.00	36
Volatile Solids x 10^4	6.13	5.89	4
Chemical Oxygen Demand x 10^4	3.31	3.34	0
Total Kjeldahl Nitrogen	1,100	1,100	0

The range of contaminant levels in the surface sediments vary widely within the San Pablo Bay-Carquinez Strait area. The zinc levels in the surface sediments found in this study range from 60 ppm near Pinole Point to 328 ppm near the entrance to Mare Island Strait. The zinc levels in San Pablo Bay proper range from 60-170 ppm in the natural channel and maintained channel to 180 ppm in the northern shallows. Zinc levels in Carquinez Strait range from 73-99 ppm on the southern side to 99-154 ppm on the northern side. The zinc level in the surface sediment of the only Mare Island Strait hole is 86 ppm.

Lead levels in the surface sediments were found to range from 12 ppm along the western end of the natural and navigation channel running through San Pablo Bay to 421 ppm at the entrance to Mare Island Strait. The highest values with the exception of the high value at the entrance to Mare Island Strait were found in San Pablo Bay proper. Here the lead levels in the surface sediments range from 12-40 ppm in the natural and navigation channel to 50-60 ppm in the northern and southern shallows. Lead levels range from 24-32 ppm along the southern side of Carquinez Strait to 48-52 ppm along the northern side. Lead levels in the surface sediment of the only Mare Island Strait hole is 59 ppm.

The lowest mercury levels in surface sediments of San Pablo Bay-Carquinez Strait area are found along the southern side of Carquinez Strait with values of 0.1 to 0.2 ppm. In contrast mercury levels along the north side of the Strait range from 0.5 ppm to 0.6 ppm. The mercury levels in the surface sediments of San Pablo Bay range from 0.4-1.0 ppm in the natural and navigation channel to 1.5-2.4 ppm in the northern and southern shallows. The highest surficial mercury level of 2.8 ppm was found along the northwestern fringe of the natural channel in San Pablo Bay. The Mare Island Strait hole had a surficial mercury value of 0.6 ppm.

The lowest cadmium levels in the surface sediments were found along the southern side of the natural channel and Carquinez Strait where the levels range from 0.3 ppm and 0.6 ppm. The highest levels ranging from 1.4 ppm to 1.6 ppm were found in the northern shallows of San Pablo Bay, north side of Carquinez Strait and Mare Island Strait. Cadmium levels near 1.0 ppm were found in the navigation channel and southern shallows of San Pablo Bay.

Copper levels found in the surface sediments of San Pablo Bay-Carquinez Strait range from 13 ppm along the southwestern side of Carquinez Strait to 85 ppm in Mare Island Strait. In the surface sediments of San Pablo Bay copper levels range from 20-40 ppm in the natural and navigation channel to 50-70 ppm in the northern and southern shallows. Copper levels from 51 ppm to 61 ppm were found along the north side of Carquinez Strait.

Chemical oxygen demand levels in the surface sediments of this area range from 0.6×10^4 ppm along the southwestern side of Carquinez Strait to 5.2×10^4 ppm in Mare Island Strait. The chemical oxygen demand levels in Carquinez Strait vary from $0.6-2.1 \times 10^4$ ppm on the south side to $4.3-4.7 \times 10^4$ ppm on the north side. In San Pablo Bay the chemical oxygen demand levels range from $1.6-4.8 \times 10^4$ ppm in the natural and navigation channel to $4.2-5.1 \times 10^4$ ppm in the surface sediments of the northern and southern shallows.

Oil-grease levels are lowest in the surface sediments along the south side of Carquinez Strait and western end of the navigation and natural channel in San Pablo Bay where levels range from 100 ppm to 300 ppm. The highest oil-grease levels were found at the entrance to Mare Island Strait (2000 ppm) and in Mare Island Strait (1700 ppm). Oil-grease levels from 600 ppm to 800 ppm were found along the northern side of Carquinez Strait. In the surface sediments of the northern and southern shallows of San Pablo Bay, oil-grease levels range from 700 ppm to 1000 ppm.

The lowest volatile solids levels in surface sediments of San Pablo Bay-Carquinez Strait area are found along the southern side of Carquinez Strait, ranging from 2.1×10^4 ppm to 3.8×10^4 ppm. The highest levels are found at the entrance to and in Mare Island Strait with concentrations of, 9.3×10^4 ppm and 9.0×10^4 ppm, respectively. Volatile solids levels along the north side of Carquinez Strait range from 7.0×10^4 ppm to 7.2×10^4 ppm. In San Pablo Bay volatile solids levels range from $7.4-8.4 \times 10^4$ ppm in the northern and southern shallows to $2.4-7.9 \times 10^4$ ppm in the natural and navigation channel.

Total Kjeldahl nitrogen levels in the surface sediments are found to range from 100-300 ppm along the south side of Carquinez Strait to 2300 ppm in Mare Island Strait. Along the north side of Carquinez Strait total Kjeldahl nitrogen levels range from 1500 ppm to 1600 ppm. In San Pablo Bay total Kjeldahl nitrogen levels range from 500 ppm to 1700 ppm.

Figures 25, 26, 27, 28, and 29 are generalized horizontal distribution maps showing lines of equal concentrations for each of the nine contaminants and median particle sizes in the surface sediments of the San Pablo Bay-Carquinez Strait area. The concentration isolines are not intended to be exact duplications of the contaminant levels, but instead, are designed to show trends in the distribution. The most apparent trend is that the spatial distribution of contaminants in the surface sediments of San Pablo Bay all show the same general distribution pattern; that is, the contaminant levels increase in a westward direction to a point opposite Pinole Point where the levels begin decreasing toward San Pablo Strait; and, moving across San Pablo Bay the contaminant levels are highest in the northern and southern shallows and decrease toward the natural and navigation channels. The lowest contaminant levels are found near the western entrance to Carquinez Strait,

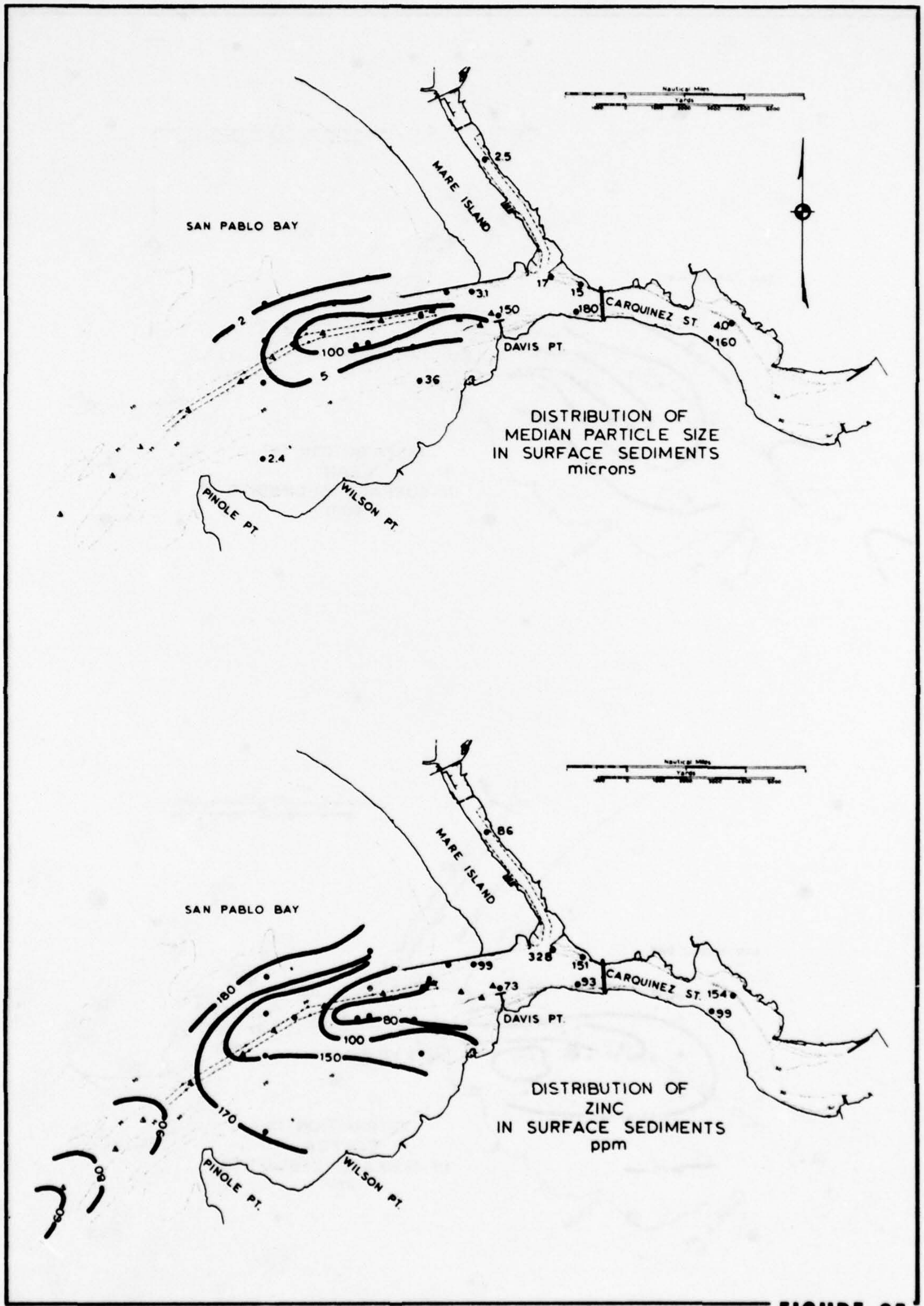
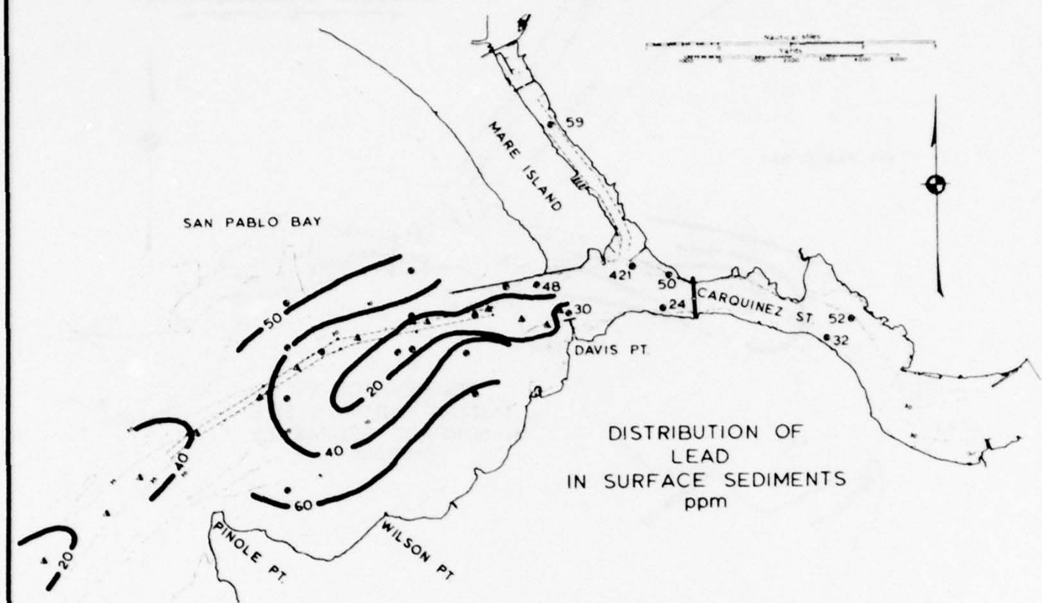
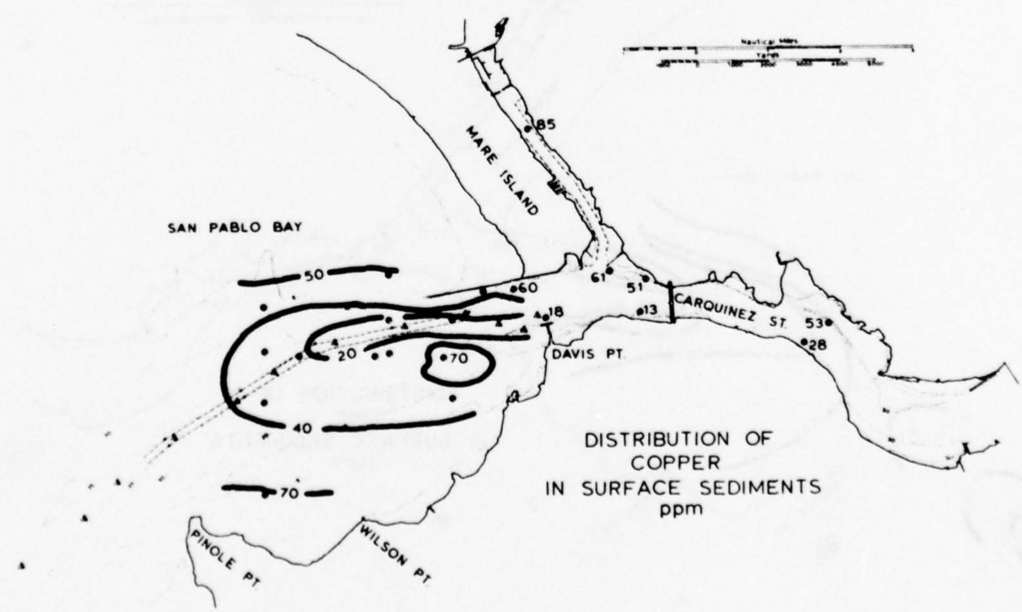

SAN PABLO BAY
MARE ISLAND
CARQUINEZ ST.
DAVIS PT.
PINOLE PT.
WILSON PT.
DISTRIBUTION OF
MEDIAN PARTICLE SIZE
IN SURFACE SEDIMENTS
microns
SAN PABLO BAY
MARE ISLAND
CARQUINEZ ST.
DAVIS PT.
PINOLE PT.
WILSON PT.
DISTRIBUTION OF
ZINC
IN SURFACE SEDIMENTS
ppm

FIGURE 25

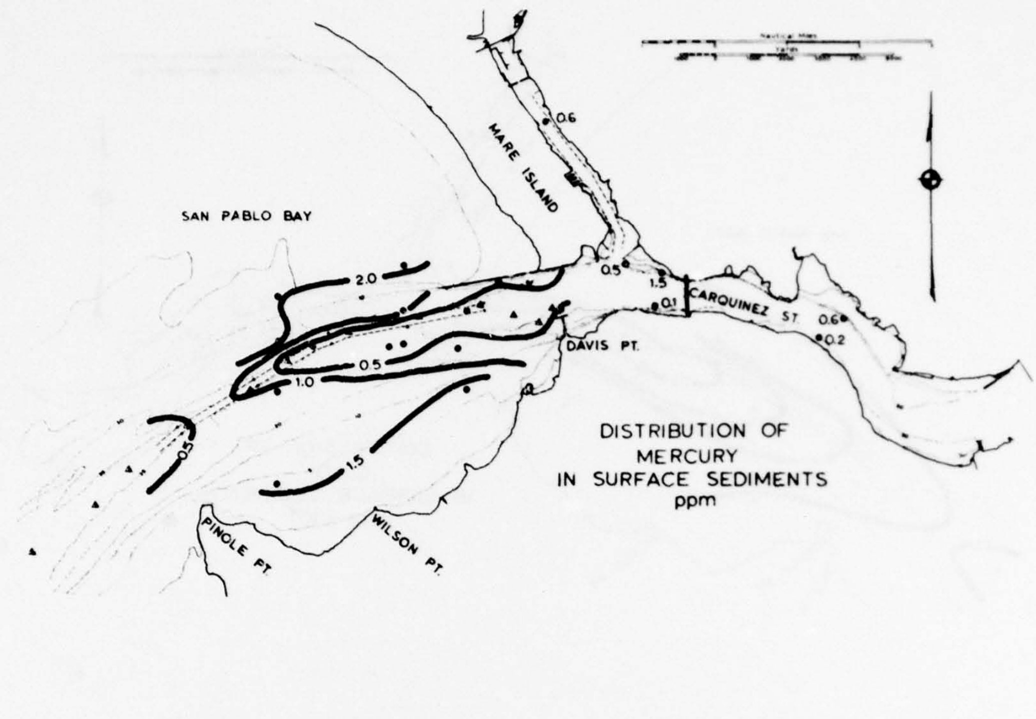


SAN PABLO BAY
MARE ISLAND
CARQUINEZ ST.
DAVIS PT.
PINOLE PT.
WILSON PT.
59
421
50
24
52
32
48
30
50
20
40
60
40
20
DISTRIBUTION OF
LEAD
IN SURFACE SEDIMENTS
ppm



SAN PABLO BAY
MARE ISLAND
CARQUINEZ ST.
DAVIS PT.
PINOLE PT.
WILSON PT.
85
61
51
13
53
28
60
18
50
20
70
40
70
DISTRIBUTION OF
COPPER
IN SURFACE SEDIMENTS
ppm

FIGURE 26


SAN PABLO BAY
MARE ISLAND
CARQUINEZ ST.
DAVIS PT.
PINOLE PT.
WILSON PT.
DISTRIBUTION OF
MERCURY
IN SURFACE SEDIMENTS
ppm
2.0
1.0
0.5
1.5
0.6
0.5
1.5
0.1
0.6
0.2

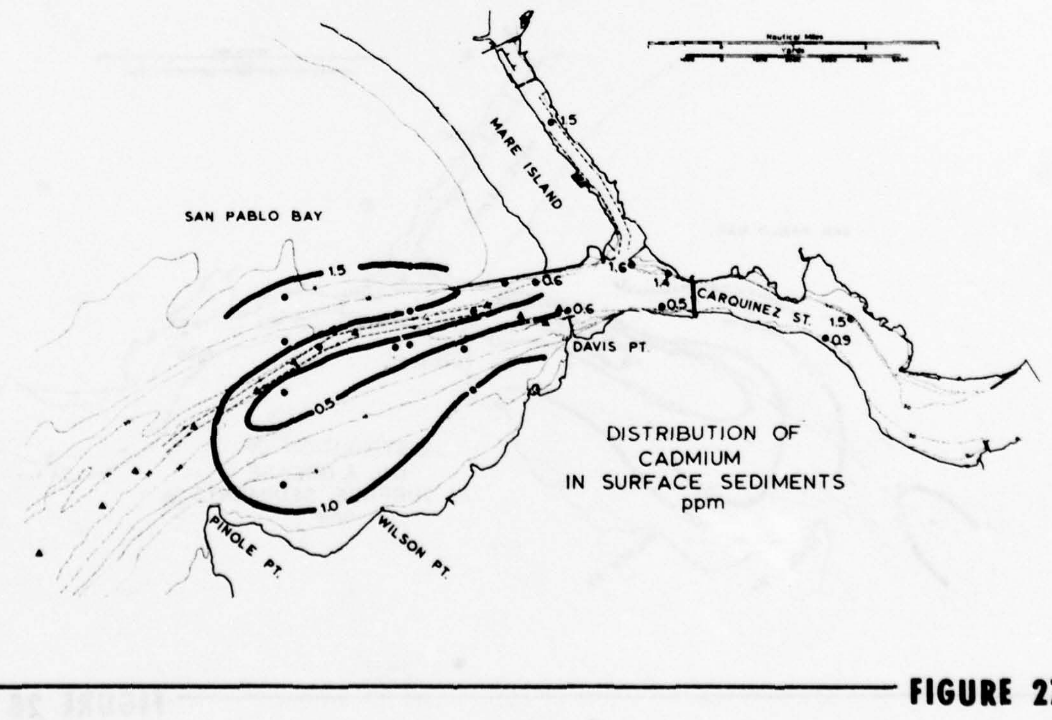

SAN PABLO BAY
MARE ISLAND
CARQUINEZ ST.
DAVIS PT.
PINOLE PT.
WILSON PT.
DISTRIBUTION OF
CADMIUM
IN SURFACE SEDIMENTS
ppm
1.5
0.5
1.0
0.6
0.6
1.6
1.4
0.5
1.5
0.9

FIGURE 27

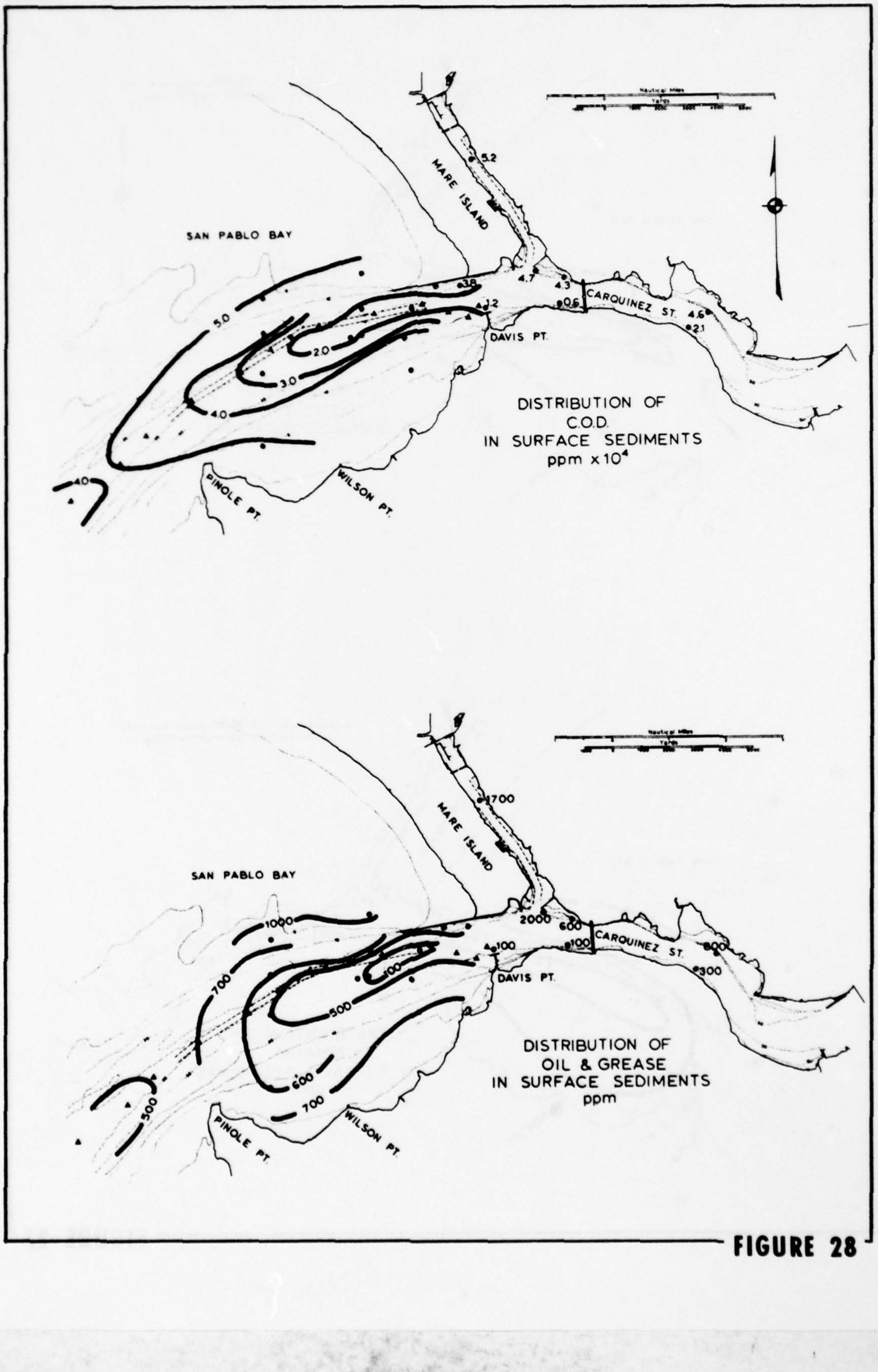

SAN PABLO BAY
MARE ISLAND
CARQUINEZ ST.
DAVIS PT.
PINOLE PT.
WILSON PT.
5.2
4.7
4.3
0.6
4.6
2.1
1.2
5.0
2.0
3.0
4.0
DISTRIBUTION OF
C.O.D.
IN SURFACE SEDIMENTS
ppm x 10^4
SAN PABLO BAY
MARE ISLAND
CARQUINEZ ST.
DAVIS PT.
PINOLE PT.
WILSON PT.
1700
2000
600
100
800
300
1000
700
500
600
700
500
DISTRIBUTION OF
OIL & GREASE
IN SURFACE SEDIMENTS
ppm

FIGURE 28

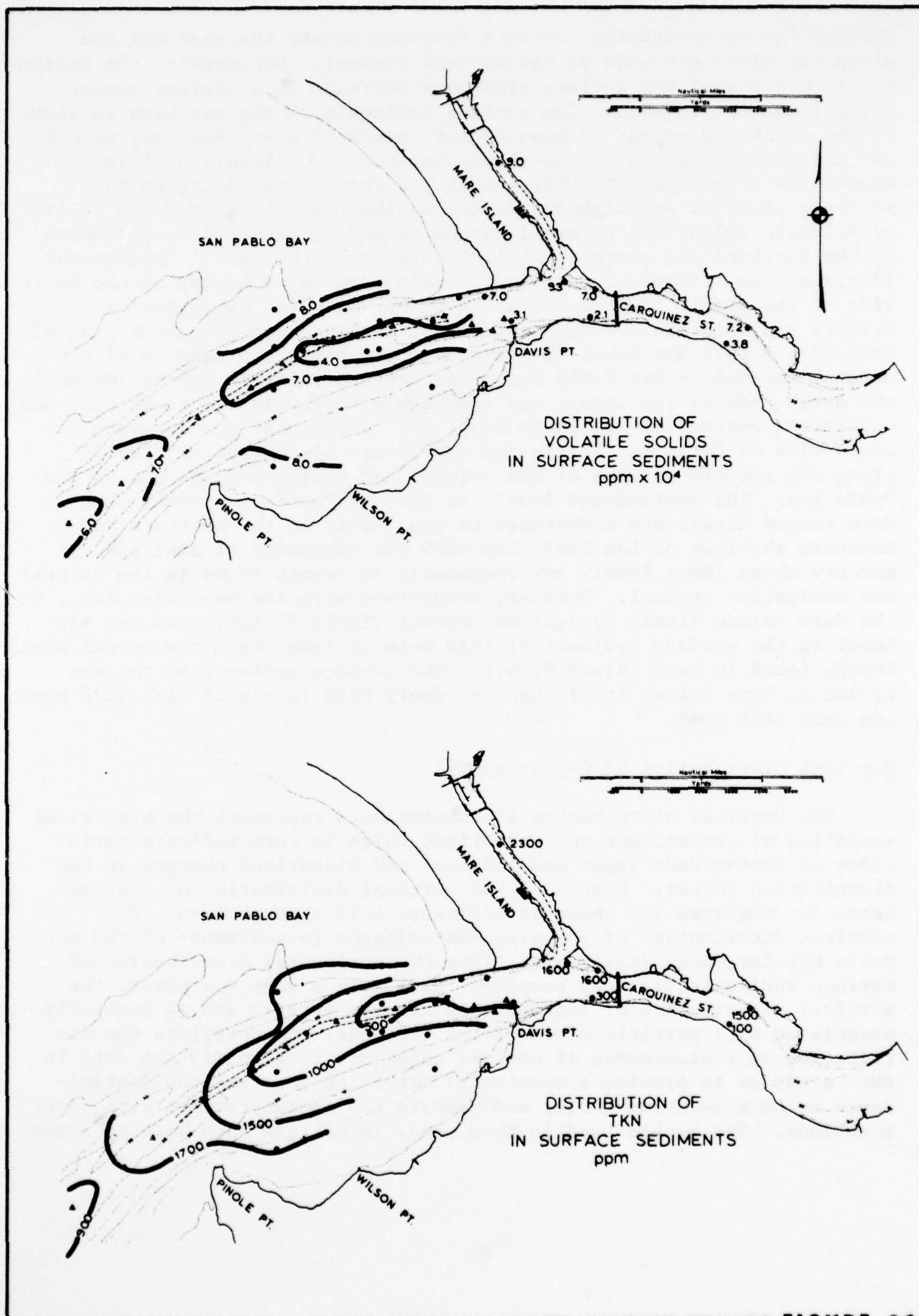

Nautical Miles
Yards
MARE ISLAND
SAN PABLO BAY
CARQUINEZ ST.
DAVIS PT.
PINOLE PT.
WILSON PT.
9.0
9.3
7.0
7.0
3.1
2.1
7.2
3.8
8.0
4.0
7.0
7.0
8.0
6.0
DISTRIBUTION OF
VOLATILE SOLIDS
IN SURFACE SEDIMENTS
ppm x 10^4
Nautical Miles
Yards
MARE ISLAND
SAN PABLO BAY
2300
1600
1600
300
CARQUINEZ ST.
1500
100
DAVIS PT.
1000
1500
1700
300
PINOLE PT.
WILSON PT.
DISTRIBUTION OF
TKN
IN SURFACE SEDIMENTS
ppm

FIGURE 29

whereby the concentration contours increase toward the west and are elongated along the axis of the natural channel. Conversely, the median particle sizes of the surface sediments decrease in a similar manner going from east to west. The surface sediments of the northern shallows of San Pablo Bay appear to have higher levels of zinc, cadmium, mercury and oil-grease than do the southern shallows. The levels of lead, copper and total Kjeldahl nitrogen in the surface sediments of the southern shallows are higher than the northern shallows, and the levels of volatile solids and chemical oxygen demand in the surface sediments of the northern and southern shallows are about the same. Contaminant levels on the fringes of Carquinez Strait tend to be higher on the north side of the strait than on the south side. With the exception of mercury and volatile solids, contaminant levels along the north side of Carquinez Strait are about the same as those along the margins of the natural channel in San Pablo Bay. Mercury and volatile solids levels on the north side of the strait are comparable to levels in the natural and navigation channel of San Pablo Bay. The contaminant levels along the south side of Carquinez Strait are comparable to contaminant levels along the eastern portion of the natural and navigation channel in San Pablo Bay. The contaminant levels in the only surface sample taken in Mare Island Strait are comparable to the levels in the northern and southern shallows of San Pablo Bay with the exception of zinc and mercury whose lower levels are comparable to levels found in the natural and navigation channel. However, comparison with the mean zinc level in the Mare Island Strait navigation channel (Table 3) indicates the zinc level in the surface sediment of this hole is lower than the normal zinc levels found in Mare Island Strait. The surface sediment at the entrance to Mare Island Strait has extremely high levels of zinc (328 ppm) and lead (421 ppm).

Vertical Distribution of Contaminants

The vertical distribution of contaminants represent the historical variation of contaminant concentrations which in turn reflects variations of contaminant input and seasonal and historical changes in the distributing forces. Graphs of the vertical distribution of contaminants for the area are shown in Inclosure 4-17 through 4-43. The vertical distribution of the nine contaminants in sediments of the San Pablo Bay-Carquinez Strait area, like the horizontal distribution of surface sediments, is very complex. Except in a very few cases, the vertical distribution of contaminants is very erratic and is generally associated with particle sizes of the sediment. To correlate the distribution of contaminants it becomes necessary to simplify the data in such a way as to provide a meaningful method to describe the contaminants in each location (hole) and compare the concentrations with other locations. The method used in this study is to rate each hole in order

of decreasing mean hole contaminant concentrations. For comparative purposes the range in concentrations and mean hole sand and clay content are also included. The holes are then compared in terms of the location contaminant rating, deviation of contaminant levels, range in contaminant levels, and variation in sediment types. The means give trends in the distribution and the deviation gives the degree of variation within holes.

Volatile Solids. The mean volatile solids concentration in the San Pablo Bay-Carquinez Strait area is $5.88 \pm 2.68 \times 10^4$ ppm*. Volatile solids in the sediment of this area range from 1.9×10^4 ppm to 16.5×10^4 ppm. Table 10 is a listing of the mean hole volatile solids concentrations in order of decreasing magnitude. Generally, as shown in Table 10 volatile solids levels are related to the sand and clay content of the sediments. Where the sediments contain a high percentage of clay the volatile solids levels normally will be high. The degree of variation (deviation) from the mean hole concentration is in most cases related to the variation of sand and clay content in the sediments of the hole. Usually where there is a large variation in the sand content of the hole, the deviation from the mean hole volatile solids concentration is also large.

Mean hole volatile solids concentrations range from 2.70×10^4 ppm in the sediments at the east end of the natural channel in San Pablo Bay to 9.07×10^4 ppm at the entrance to Mare Island Strait on the north side of Carquinez Strait. Hole 2D-115(31) at the entrance to Mare Island Strait has the highest mean volatile solids concentration of $9.07 \pm 0.3 \times 10^4$ ppm. The distribution of volatile solids in the sediment of the hole is very uniform, as is indicated by the small standard deviation. The sediment in the hole, however, varies considerably with depth. The surface sample of this hole has a high sand content (40 percent), yet still has a high volatile solids concentration of 9.3×10^4 ppm. The deeper sediment is much more uniformly distributed silty clay with correspondingly high volatile solids levels.

Hole 2D-116(32) in Mare Island Strait and 2D-126(25) and 2D-125(23) in the northern shallows of San Pablo Bay, like 2D-115(31), have high mean hole volatile solids concentrations with small standard deviations. The mean hole concentrations vary from $8.97 \pm 0.3 \times 10^4$ ppm in Mare Island Strait to $8.33 \pm 0.2 \times 10^4$ ppm at the eastern end of the northern shallows. The distribution of volatile solids with depth in these holes is very uniform. The sediments are also very uniformly distributed silty clay with less than two percent sand content and greater than fifty percent clay.

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* The $\pm$ value with the mean is the standard deviation.

TABLE 10

SAN PABLO BAY-CARQUINEZ STRAIT

MEAN HOLD VOLATILE SOLIDS CONCENTRATIONS

Rating	Hole	Mean ppm x 10^4	Range ppm x 10^4	% Sand >74 μ	% Clay <2 μ
1.	2D-115(31)	9.07±0.3	8.8-9.3	15±21	40±13
2.	2D-116(32)	8.97±0.3	8.7-9.2	1±1	49±3
3.	2D-126(25)	8.40±0.4	8.0-8.9	1±1	53±4
4.	2D-125(23)	8.33±0.2	8.0-8.5	2±1	53±3
5.	2D-118(34)	8.28±4.0	3.8-16.5	44±17	17±6
6.	2D-120(17)	8.00±2.7	5.8-13.1	28±16	24±7
7.	2D-114(33)	7.65±0.7	6.6-8.2	15±11	36±8
8.	2D-117(35)	7.30±0.4	6.7-7.5	9±2	32±6
9.	2D-123(28)	6.72±1.4	4.8-8.4	8±14	36±11
10.	2D-131(30)	5.80±2.4	3.1-7.8	32±33	27±14
11.	2D-124(27)	5.42±2.4	2.5-7.9	34±34	30±18
12.	2D-121(21)	5.29±2.4	2.2-8.0	39±33	26±16
13.	2D-119(29)	5.12±1.6	2.1-6.4	47±23	19±10
14.	2D-128(26)	5.05±1.7	3.2-7.7	37±25	24±11
15.	2D-164(15)	4.23±1.4	3.3-6.3	62±17	12±5
16.	2D-132(16)	4.12±1.9	2.4-7.0	56±32	21±13
17.	2D-127(19)	3.37±0.6	2.7-3.7	54±16	19±5
18.	2D-122(22)	3.32±0.7	2.2-3.8	60±20	15±8
19.	2D-133(18)	3.18±1.3	2.1-5.3	69±15	14±8
20.	2D-129(24)	2.96±0.8	2.3-4.2	70±14	11±7
21.	2D-130(20)	2.70±0.8	1.9-4.0	73±17	10±7

Holes 2D-118(34), on the south side of Carquinez Strait and 2D-120(17) in the southern shallows of San Pablo Bay have high mean hole volatile solids levels and also extremely large deviatiions from the means. The sediments of these holes are coarser than the preceding holes with fairly large variations in sand content. The mean hole volatile solids concentration for 2D-118(34) and 2D-120(17) are, respectively, $8.28 \pm 4.0 \times 10^4$ ppm and $8.00 \pm 2.7 \times 10^4$ ppm. The sediments of these holes have a wide variation in sand content as is indicated by the deviation from the mean sand content. The sand content in 2D-118(34) varies from 22 to 78 percent and in 2D-120(17) the sand content varies from 11 to 48 percent. Two anomalous samples in 2D-118(34) and one in 2D-120(17) are responsible for the large deviation from the mean hole volatile solids concentrations. The three anomalous samples with high volatile solids values are found in the intermediate depth samples of each hole and are associated with samples with high sand contents. The two high volatile solids samples in 2D-118(34) with values of 16.5×10^4 ppm and 13.2×10^4 ppm have sand contents of 32 percent and 22 percent, respectively. The logs of borings indicate that the high volatile solids samples in 2D-118(34) contain dark lenses of organic clay. The high volatile solids sample in 2D-120(17) with a value of 13.1×10^4 ppm has a sand content of 48 percent.

Holes 2D-114(33) and 2D-117(35), both on the north side of Carquinez Strait have mean hole volatile solids levels ranging from $7.65 \pm 0.7 \times 10^4$ ppm to $7.30 \pm 0.4 \times 10^4$ ppm. The deviation from the mean concentrations in these holes are less than ten percent, indicating that the distribution of volatile solids is uniform with depth. The sediments of 2D-114(33). The sediments of 2D-117(35) located further to the east of 2D-114(33) are uniformly distributed with depth and are finer than in 2D-114(33). The volatile solids levels in 2D-117(35), despite the finer sediments are lower than in 2D-114(33).

Hole 2D-123(28), at the west end of the southern shallows in San Pablo Bay has a mean hole volatile solids concentration of $6.72 \pm 1.4 \times 10^4$ ppm. The large deviation from the mean concentration (greater than 20 percent) is due to the presence of one gross sandy silt bed (32 percent sand) with a moderately low volatile solids concentration of 4.8×10^4 ppm.

Hole 2D-131(30) at the south side of the entrance to Carquinez Strait, 2D-124(27) in the natural channel, 2D-121(21) at the east end of the southern shallows, 2D-119(29) on the south side of Carquinez Strait, and 2D-128(26) in the natural channel of San Pablo Bay have mean hole volatile solids concentrations slightly less than the San Pablo Bay-Carquinez Strait area mean. The deviations from the mean in these holes

are large (30 to 40 percent of the mean concentration). The sediments are fairly coarse with mean hole sand contents varying from 30 to 50 percent. The large variation in sand content within these holes indicate highly stratified sediments with numerous beds of clayey and silty material. The mean hole volatile solids concentrations in these holes vary from $5.80 \pm 2.4 \times 10^4$ ppm to $5.05 \pm 1.7 \times 10^4$ ppm. The high deviations from the mean concentrations in 2D-124(27), 2D-121(21) and 2D-128(26) are due to high volatile solids levels in the near surface sediments which are comprised of a finer material with a lesser sand content. The surface sediments of 2D-131(30) are coarser with low volatile solids levels. The surface sediments of 2D-119(29) are extremely coarse with a sand content of 93 percent. The deeper samples of 2D-119(29) with the sand content varying from 35 to 45 percent have volatile solids concentrations that appear high in relationship to the sand content.

Holes 2D-164(15) on the east end of the navigation channel in San Pablo Bay and 2D-132(16) on the north side of the entrance to Carquinez Strait have moderately low mean volatile solids concentrations and large deviations from the mean. The sediments in these holes are primarily comprised of sandy material with the mean clay content varying from 10 to 20 percent. The mean hole volatile solids concentrations of 2D-164(15) and 2D-132(16) are $4.23 \pm 1.4 \times 10^4$ ppm and $4.12 \pm 1.9 \times 10^4$ ppm, respectively. The large deviations in the mean concentration in both holes are due to the near surface sediments which are enriched with volatile solids. The near surface sediments of 2D-132(16) are considerably finer than the deeper sediments and are comprised of a clayey silt material, with a sand content of less than ten percent. The surface sediments of 2D-164(15) are the coarsest of the hole (77 percent sand), yet have a volatile solids concentration approximately fifty percent higher than the deeper sediments.

Holes 2D-127(19) at the west end of the navigation channel in San Pablo Bay, 2D-122(22) on the southeast side of the natural channel, 2D-133(18) on the north side of the entrance to Carquinez Strait, and 2D-129(24) and 2D-130(20) on the north and south side of the natural channel have the lowest mean hole volatile solids concentrations in the San Pablo Bay-Carquinez Strait area. The deviations from the mean hole concentrations are also small. The sediments of these holes have the largest sand content of the area with most of the sediments being classified as clayey to silty sand. The mean hole volatile solids concentrations range from $3.37 \pm 0.6 \times 10^4$ ppm at the west end of the navigation channel to $2.70 \pm 0.8 \times 10^4$ ppm on the south side of the natural channel near the entrance to Carquinez Strait. The sediments are primarily sand and on the whole have lesser variations in the sand content than the preceding holes. The distribution of volatile solids is fairly uniform with depth. The surface sample of 2D-133(18) is enriched with volatile solids resulting in a larger standard deviation than the other holes.

Chemical Oxygen Demand. The mean chemical oxygen demand (COD) in the San Pablo Bay-Carquinez Strait area is $3.30 \pm 2.1 \times 10^4$ ppm. The range in C.O.D. concentrations in the sediments of this area is very large, varying from 0.4×10^4 ppm to 15.7×10^4 ppm. Table 11 is the listing of the mean hole COD concentrations in order of decreasing magnitude. Generally, COD levels in the sediments of this area, like volatile solids, are related to the sand and clay content, that is, where the sand percentages in the sediments are high, the chemical oxygen demand is normally low.

Hole 2D-118(34) on the south side of Carquinez Strait has the highest mean hole COD concentration of $6.44 \pm 4.5 \times 10^4$ ppm. It is comprised of anomalously coarse sediment with a mean sand content of 44 percent and a clay content of only 17 percent. The large deviation from the mean concentration is due to the same two samples responsible for the high volatile solids mean concentration and standard deviation. The COD values for these two samples are 12.3×10^4 ppm and 15.7×10^4 ppm, the two highest COD. sample concentrations in the San Pablo Bay-Carquinez Strair area.

Holes 2D-115(31) and 2D-114(33) located on the north side of Carquinez Strait near the entrance to Mare Island have mean hole COD concentrations of $4.20 \pm 0.8 \times 10^4$ ppm and $3.93 \pm 0.4 \times 10^4$ ppm, respectively. The distribution of COD in these holes is fairly uniform deviation with depth despite the presence of coarser material in the first six feet of sediment. The deeper sediments of these holes are extremely fine as is indicated by the mean hole clay content of greater than 35 percent. The large deviation from the mean hole sand content is due to coarser surface sediments that have anomalously high COD levels.

Hole 2D-120(17) at the eastern end of the southern shallows with a mean hole COD concentration of $4.12 \pm 1.5 \times 10^4$ ppm has a higher sand content and lower clay content than other holes with comparable mean concentrations. The large deviation from the mean hole concentration is due to the deeper sediment (between 7 and 15 feet below Bay bottom) being enriched with COD. The high COD levels in these deeper sediments, ranging from 5.1×10^4 ppm to 5.6×10^4 ppm are not reflected in either the sand or clay content of these samples.

Holes 2D-126(25) and 2D-125(23) in the northern shallows of San Pablo Bay appear to have somewhat lower mean COD concentrations and larger standard deviations than would be expected by the uniformly distributed fine sediments. The large deviations from the mean hole concentrations are the result of a surface COD enrichment and a general decrease in COD concentrations with depth. Hole 2D-126(25) at the west end of the southern shallows has somewhat larger COD levels than 2D-125(23).

TABLE 11

SAN PABLO BAY-CARQUINEZ STRAIT

MEAN HOLE CHEMICAL OXYGEN DEMAND CONCENTRATIONS

Rating	Hole	Mean ppm x 10^4	Range ppm x 10^4	% Sand > 74 μ	% Clay <2 μ
1.	2D-118(34)	6.44±4.5	5.1-15.7	44±17	17±6
2.	2D-116(32)	5.50±0.4	5.2-6.0	1±1	49±3
3.	2D-123(28)	4.54±1.0	2.8-5.1	8±14	36±11
4.	2D-115(31)	4.20±0.8	3.2-4.7	15±21	40±13
5.	2D-120(17)	4.12±1.5	1.7-5.6	28±16	24±7
6.	2D-114(33)	3.93±0.4	3.2-4.3	15±11	36±8
7.	2D-117(35)	3.78±0.6	3.0-4.6	9±2	32±6
8.	2D-126(25)	3.65±1.2	2.4-4.9	1±1	53±4
9.	2D-128(26)	3.65±1.5	1.3-5.2	37±25	24±11
10.	2D-124(27)	3.28±2.4	1.5-5.1	34±34	30±18
11.	2D-125(23)	3.28±1.1	2.3-4.8	2±1	53±3
12.	2D-121(21)	2.80±1.6	0.4-5.0	39±33	26±16
13.	2D-119(29)	2.35±1.3	0.6-4.2	47±23	19±10
14.	2D-132(16)	2.34±1.3	0.9-3.8	56±32	21±13
15.	2D-127(19)	2.30±0.9	1.5-3.2	54±16	19±5
16.	2D-122(22)	2.18±0.8	0.9-2.7	60±20	15±8
17.	2D-164(15)	2.05±0.4	1.6-2.5	62±17	12±5
18.	2D-133(18)	1.88±0.8	1.0-2.7	69±15	14±8
19.	2D-130(20)	1.60±1.2	0.5-3.7	73±17	10±7
20.	2D-131(30)	1.57±0.3	1.2-1.8	32±33	27±14
21.	2D-129(24)	1.40±0.3	1.0-1.9	70±14	11±7

Hole 2D-131(30) located on the south side of the entrance to Carquinez Strait has an erroneously low mean hole COD concentration ($1.60 \pm 0.3 \times 10^4$ ppm) when compared to the relatively low sand content of 32 ± 33 percent.

The highest COD concentrations (greater than 6×10^4 ppm) in the sediments of the San Pablo Bay-Carquinez Strait area are found at hole 2D-118(34) on the south side of Carquinez Strait, east of the Carquinez Bridge. The second highest COD concentrations with mean hole values ranging from 3.8×10^4 ppm to 5.5×10^4 ppm are found in Mare Island Strait, the north side of Carquinez Strait and the southern shallows of San Pablo Bay. The northern shallows of San Pablo Bay and the western end of the natural channel also have high mean hole concentrations ranging from 3.3×10^4 ppm to 3.7×10^4 ppm.

The lowest COD concentrations are found at the entrance to Carquinez Strait and in the maintained and natural channel through the southern portion of San Pablo Bay.

Total Kjeldahl Nitrogen. The mean total Kjeldahl nitrogen (TKN) concentration in the San Pablo Bay-Carquinez Strait area is 1100 ± 600 ppm. TKN concentrations in the sediments of this area range from 300 ppm to 3400 ppm. Table 12 is a listing of the mean hole TKN concentrations in order of decreasing magnitude. As with C.O.D. and volatile solids, TKN concentrations are normally low when the sand content in the sediments is high.

Hole 2D-118(34) on the south side of Carquinez Strait, and holes 2D-115(31) and 2D-114(33) on the north side of Carquinez Strait near the entrance to Mare Island Strait have high TKN concentrations for the same reasons that they also have high volatile solids and C.O.D. concentrations. Holes 2D-125(23) and 2D-126(25) in the northern shallows of San Pablo Bay have somewhat lower TKN concentrations than would be expected by the extremely fine sediments. Hole 2D-132(16) on the north side of the entrance to Carquinez Strait has somewhat higher TKN concentrations than would be expected by the relatively coarse sediments.

The highest mean hole TKN concentration (2200 ppm) is found in Mare Island Strait where the sediments are very fine with less than one percent sand content. High concentrations are also found on the northern and southern sides of Carquinez Strait where the mean hole concentrations range from 1600 ppm to 1700 ppm. The greatest range of sample concentrations (700 ppm to 3400 ppm) are also found in this area at hole 2D-118(34). The northern and western southern shallows of San Pablo Bay

TABLE 12

SAN PABLO BAY-CARQUINEZ STRAIT

MEAN HOLE TOTAL KJELDAHL NITROGEN CONCENTRATIONS

Rating	Hole	Mean ppm x 10^4	Range ppm x 10^4	% Sand >74 μ	% Clay <2 μ
1.	2D-116(32)	2200±100	2100-2300	1±1	49±3
2.	2D-118(34)	1700±400	700-3400	44±17	17±6
3.	2D-115(31)	1700±400	1400-2200	15±21	40±13
4.	2D-114(33)	1600±300	1200-2000	15±11	36±8
5.	2D-117(35)	1600±200	1300-1800	9±2	32±6
6.	2D-123(28)	1400±500	800-1300	8±14	36±11
7.	2D-126(25)	1400±300	1000-1600	1±1	53±4
8.	2D-125(23)	1300±300	800-1500	2±1	53±3
9.	2D-128(26)	1200±500	400-1800	37±25	24±11
10.	2D-120(17)	1000±400	500-1600	28±16	24±7
11.	2D-124(27)	1000±600	300-1800	34±34	30±18
12.	2D-131(30)	900±400	500-1100	32±33	27±14
13.	2D-132(16)	900±400	400-1300	56±32	21±13
14.	2D-121(21)	900±400	300-1400	39±33	26±16
15.	2D-119(29)	800±400	300-1300	47±23	19±10
16.	2D-127(19)	800±200	700-1100	54±16	19±5
17.	2D-164(15)	800±100	800-900	62±17	12±5
18.	2D-133(18)	700±400	400-1200	69±15	14±8
19.	2D-122(22)	700±200	400-1000	60±20	15±8
20.	2D-130(20)	600±200	400-1000	73±17	10±7
21.	2D-129(24)	500±100	400-600	70±14	11±7

have high mean hole TKN concentrations ranging from 1300 ppm to 1400 ppm. The sediments in this area are generally fine. The eastern southern shallows, entrance to Carquinez Strait and the western end of the natural and maintained channel in San Pablo Bay have mean TKN concentrations ranging from 800 ppm to 1200 ppm. The lowest TKN concentrations are found on the eastern end of the natural and maintained channel in San Pablo Bay.

Oil-Grease. The mean oil-grease concentration in the San Pablo Bay-Carquinez Strait area is 500 ± 500 ppm. Oil-grease concentrations in the sediments range from 100-2000 ppm. Table 13 is a listing of the mean hole oil-grease concentrations in order of decreasing magnitude. The vertical distribution of oil-grease within holes is erratic, with the standard deviation normally exceeding fifty percent of the mean concentration. The sand-clay content: oil-grease concentration relationship is less clearly defined than with the preceding contaminants, although the trend for high oil-grease concentrations to be associated with low sand content is apparent.

Mean hole oil-grease concentrations greater than 1000 ppm are found in the sediments at the entrance to and in Mare Island Strait, and at the west end of the northern San Pablo Bay shallows. The surface sediment in hole 2D-115(31) at the entrance to Mare Island Strait has a high oil-grease level despite having a large sand content (40 percent sand).

Mean hole oil-grease concentrations between 600 ppm and 900 ppm are found on the north side of Carquinez Strait, western San Pablo Bay shallows, the south side of Carquinez Strait, and the north side of the entrance to Carquinez Strait. Holes 2D-118(34) and 2D-132(16) with mean sand contents of 44 percent and 56 percent, respectively, have exceedingly high oil-grease levels. Hole 2D-132(16) is especially interesting in that the upper two samples (5 feet below Bay bottom) have oil-grease values greater than 1400 ppm, whereas the other organic parameters (volatile solids, chemical oxygen demand, and total Kjeldahl nitrogen) are not exceedingly high. The first five feet of sediment in the hole is the finest, with the sand content varying from 9 percent to 40 percent. The sediment below five feet has a sand content greater than 60 percent.

Hole 2D-133(18) with a mean hole sand content of 69 percent appears to have a somewhat higher mean oil-grease concentration (400 ± 300) than would be expected from the relatively coarse sediment. Like hole 2D-132(16) this hole is located on the north side of the entrance to Carquinez Strait. Conversely, hole 2D-123(28) in the southern shallows

TABLE 13

SAN PABLO BAY-CARQUINEZ STRAIT

MEAN HOLE OIL-GREASE CONCENTRATIONS

Rating	Hole	Mean ppm x 10^4	Range ppm x 10^4	% Sand > 74 μ	% Clay <2 μ
1.	2D-115(31)	1200±900	300-2000	15±21	40±13
2.	2D-125(23)	1200±500	700-1800	2±1	53±3
3.	2D-116(32)	1100±600	700-1700	1±1	49±3
4.	2D-126(25)	900±500	700-1400	1±1	53±4
5.	2D-114(33)	900±400	400-1400	15±11	36±8
6.	2D-118(34)	800±600	300-1200	44±17	17±6
7.	2D-132(16)	800±600	300-1600	56±32	21±13
8.	2D-117(35)	600±300	300-900	9±2	32±6
9.	2D-124(27)	500±400	200-1100	34±34	30±18
10.	2D-121(21)	400±300	100-700	39±33	26±16
11.	2D-133(18)	400±300	100-800	69±15	14±8
12.	2D-123(28)	400±100	200-600	8±14	36±11
13.	2D-120(17)	300±400	200-700	28±16	24±7
14.	2D-131(30)	300±200	100-500	32±33	27±14
15.	2D-128(26)	300±200	100-600	37±25	24±11
16.	2D-119(29)	300±100	100-500	47±23	19±10
17.	2D-129(24)	200±200	100-600	70±14	11±7
18.	2D-127(19)	200±100	100-300	54±16	19±5
19.	2D-164(15)	200±100	100-300	62±17	12±5
20.	2D-122(22)	100±0	100-200	60±20	15±8
21.	2D-130(20)	100±0	100-200	73±17	10±7

of San Pablo Bay has a lower mean hole concentration (400 ppm) than would be expected by the relatively small sand content (8 percent). This high mean hole oil-grease concentration is due to the surface sediment which is extremely fine (less than 2 percent sand content).

Mercury. The mean mercury concentration in the San Pablo Bay-Carquinez Strait area is 0.75±0.60 ppm. Mercury concentrations in the sediments of this area range from 0.10 ppm to 3.0 ppm. Table 14 is a listing of the mean hole mercury concentrations in order of decreasing magnitude.

Mean hole mercury concentrations range from 0.32±0.11 ppm in the sediments on the south side of the natural channel to 1.95±0.90 ppm in the northern shallows of San Pablo Bay. Holes 2D-126(25) and 2D-125(23) have the highest mean hole mercury concentrations of 1.95±0.90 ppm and 1.88±0.41 ppm, respectively. Both these holes have a clay content exceeding 50 percent. The large deviation from the mean hole mercury concentration in 2D-126(25) is due to an exceptionally high mercury value (3.0 ppm) at 2.5 feet below Bay bottom.

Holes 2D-115(31) and 2D-114(33) located near the entrance to Mare Island Strait and hole 2D-123(28) at the western end of the southern San Pablo Bay shallows have mean hole mercury concentrations that range from 0.82±0.34 ppm to 1.03±1.2 ppm. The high mean hole concentrations can be expected, due to the high clay content (36 to 40 percent). The large deviation from the mean hole value in 2D-115(31) is the result of one sample at 8 feet below Bay bottom having a mercury concentration of 2.4 ppm. This sample has a sand content of only 4 percent.

Holes 2D-128(26) and 2D-127(19) at the western end of the natural channel, hole 2D-119(29) on the south side of Carquinez Strait, and hole 2D-120(17) at the eastern end of the southern shallows have mean hole mercury concentrations greater than 0.80 ppm with large standard deviations. The sand content of the sediments in these holes is fairly large and the mean hole clay content is less than 25 percent. The deviations from the mean hole mercury concentrations are all greater than 50 percent and are due primarily to the surface sediments being enriched with mercury. The two deepest samples in hole 2D-119(29) have mercury concentrations between one and two parts per million, yet the sand content of these samples is greater than 35 percent.

Hole 2D-116(32) in Mare Island Strait and 2D-117(35) on the north side of Carquinez Strait have lower mercury concentrations than would be expected by the fine sediments. Hole 2D-132(16) with a mean sand content of 56±32 percent has a slightly greater mean hole mercury concentration (0.66±0.21 ppm) than would be expected by the fairly coarse sediments. Hole 2D-129(24) also has a higher mean hole mercury concentration than would be expected by the presence of the high sand content of 70 percent.

TABLE 14

SAN PABLO BAY-CARQUINEZ STRAIT

MEAN HOLE MERCURY CONCENTRATIONS

Rating	Hole	Mean ppm x 10^4	Range ppm x 10^4	% Sand > 74 μ	% Clay <2 μ
1.	2D-126(25)	1.95±0.90	0.8-3.0	1±1	53±4
2.	2D-125(23)	1.88±0.41	1.4-2.4	2±1	64±3
3.	2D-115(31)	1.03±1.2	0.2-2.4	15±21	40±13
4.	2D-128(26)	1.0 ±0.92	0.4-2.8	37±25	24±11
5.	2D-119(29)	0.98±0.70	0.1-2.1	47±23	19±10
6.	2D-123(28)	0.86±0.36	0.5-1.3	8±14	36±11
7.	2D-120(17)	0.83±0.64	0.3-1.7	28±16	24±7
8.	2D-114(33)	0.82±0.34	0.6-1.5	15±11	36±8
9.	2D-127(19)	0.80±0.78	0.3-1.7	54±16	19±5
10.	2D-116(32)	0.67±0.06	0.6-0.7	1±1	49±3
11.	2D-132(16)	0.66±0.21	0.4-0.9	56±32	21±13
12.	2D-117(35)	0.66±0.11	0.5-0.8	9±2	32±6
13.	2D-131(30)	0.63±0.06	0.6-0.7	32±33	27±14
14.	2D-124(27)	0.62±0.70	0.1-1.8	34±34	30±18
15.	2D-129(24)	0.56±0.46	0.2-1.2	70±14	11±7
16.	2D-121(21)	0.56±0.40	0.2-1.3	39±33	26±16
17.	2D-118(34)	0.41±0.14	0.2-0.7	44±17	17±6
18.	2D-130(20)	0.40±0.14	0.2-0.6	73±17	10±7
19.	2D-164(15)	0.40±0.08	0.3-0.5	62±17	12±5
20.	2D-133(18)	0.36±0.09	0.3-0.5	69±15	14±8
21.	2D-122(22)	0.32±0.11	0.3-0.5	60±20	15±8

The lowest mean hole mercury concentrations (less than 0.60 ppm) are found at the west end of the natural and maintained channel in San Pablo Bay. Hole 2D-118(34) has a surprisingly low mean hole mercury concentration when compared to the mean hole concentrations of other contaminants found at the hole.

Lead. The mean lead concentration in the San Pablc Bay-Carquinez Strait area is 37.2±51.5 ppm. Lead concentrations in the sediment of this area range from 7.0 ppm to 421 ppm. Table 15 is a listing of mean hole lead concentrations in order of decreasing magnitude. The mean hole lead concentrations range from 11.0±5.7 ppm on the west end of the natural channel 295.3±142.8 ppm at the entrance to Mare Island Strait.

Mean hole lead concentrations, like the other contaminants, are generally associated with the mean sand-clay content of the holes. The major exceptions to the sand-clay content - lead concentration relationship are holes 2D-115(31) and 2D-114(33) near the entrance to Mare Island Strait; 2D-119(29) and 2D-118(34) on the south side of Carquinez Strait; and 2D-123(28) at the west end of the southern shallows.

Hole 2D-115(31) at the entrance to Mare Island Strait has extremely high lead concentrations ranging from 140 ppm to 421 ppm. The surface sample at this hole has a sand content of 40 percent, yet has the highest lead value found in the San Pablo Bay-Carquinez Strait area. Hole 2D-114(33) located to the east of 2D-115(31) on the north side of Carquinez Strait has a mean hole lead concentration of 47.7±4.5 ppm. The distribution of lead is very uniform with depth, as is indicated by the deviation from the mean. Holes 2D-119(29) and 2D-118(34) on the south side of Carquinez Strait have exceptionally high mean hole lead concentrations when compared to the mean sand content of the holes. Hole 2D-123(28) in the western southern shallows of San Pablo Bay is comprised of very fine sediment (mean sand content 8±4 percent), yet the mean hole lead concentration is only 28.6±17.6 ppm. The large deviation from the mean hole lead concentration in 2D-123(28) is due to high lead levels in the extremely fine surface sediment. The two deepest samples of this hole at depths greater than 15 feet below Bay bottom are even finer than the surface sediment (sand content of 0 percent); however, the lead content is only 21 ppm.

Zinc. The mean zinc concentration in San Pablo Bay-Carquinez Strait area is 111.4±53.0 ppm. Zinc concentrations in the sediment of this area range from 38 ppm to 328 ppm. Table 16 is a listing of the mean hole zinc concentrations in order of decreasing magnitude. The mean hole zinc concentrations range from 287±46.8 ppm at the entrance to Mare Island Strait to 55.4±21.2 ppm on the north side of the entrance to Carquinez Strait.

TABLE 15

SAN PABLO BAY-CARQUINEZ STRAIT

MEAN HOLE LEAD CONCENTRATIONS

Rating	Hole	Mean ppm	Range ppm	% Sand >74 μ	% Clay <2 μ
1.	2D-115(31)	295.3±142.8	140-421	15±21	40±13
2.	2D-116(32)	64.7±5.1	59-69	1±1	49±3
3.	2D-114(33)	47.7±4.5	42-55	15±11	36±8
4.	2D-119(29)	46.2±20.3	22-67	47±23	19±10
5.	2D-117(35)	44.6±9.6	32-55	9±2	32±6
6.	2D-118(34)	38.0±10.0	26-58	44±17	17±6
7.	2D-126(25)	35.5±14.1	19-53	1±1	53±4
8.	2D-125(23)	34.0±10.2	24-48	2±1	53±3
9.	2D-131(30)	29.0±1.7	27-30	32±33	27±14
10.	2D-123(28)	28.6±17.6	15-59	8±4	36±11
11.	2D-120(17)	27.7±17.3	17-62	28±16	24±7
12.	2D-132(16)	26.6±13.4	16-48	56±32	21±13
13.	2D-121(21)	24.3±14.0	12-54	39±33	26±16
14.	2D-124(27)	22.8±6.7	14-30	34±34	30±18
15.	2D-127(19)	22.0±8.7	17-32	54±16	19±5
16.	2D-133(18)	21.8±16.4	14-51	69±16	14±8
17.	2D-128(26)	20.7±9.4	13-39	37±25	24±11
18.	2D-130(20)	17.2±3.7	12-22	73±17	10±7
19.	2D-122(22)	16.0±2.9	14-21	60±20	15±8
20.	2D-164(15)	12.8±1.0	12-14	62±17	12±5
21.	2D-129(24)	11.0±5.7	7-21	70±14	11±7

The mean hole zinc concentrations are generally associated with the sand-clay content as is shown in Table 16. Holes 2D-115(31) and 2D-114(33) near the entrance to Mare Island Strait have very high zinc concentrations. The highest sample zinc concentrations in these two holes are associated with the coarsest sediment near the surface. The deeper sediments also have high zinc levels, but these sediments are fine with less than ten percent sand content. Hole 2D-119(29) located across Carquinez Strait from the entrance to Mare Island Strait has very high zinc concentrations when compared to the sand-clay content. For instance, at a depth of 2.5 to 5.0 feet below Bay bottom with a sand content of greater than 35 percent, the zinc level is greater than 180 ppm. Holes 2D-126(25) and 2D-125(23) located in the northern San Pablo Bay shallows have zinc levels ranging from 86 ppm to 179 ppm. Zinc levels in these two northern shallows' holes decrease uniformly with depth.

The highest zinc concentrations in the San Pablo Bay-Carquinez Strait area were found at the entrance to and in Mare Island Strait; on the south side of Carquinez Strait opposite the entrance to Mare Island Strait and on the north side of Carquinez Strait; in the northern shallows of San Pablo Bay; and at the western end of the southern shallows. With the exception of hole 2D-119(29), the sediments in these areas are the finest in the San Pablo Bay-Carquinez Strait area, rarely having sand contents exceeding 15 percent. In most cases the vertical distribution of zinc is very erratic regardless of the uniformity or herogenity of the sediment in these holes. The lowest zinc levels in these holes range from 84-236 ppm and the high levels range from 175-328 ppm.

Intermediate mean hole zinc concentrations between 90 ppm and 112 ppm were found in the sediments of the western end of the natural channel, the navigation channel, east end of the southern shallows, and on the south side of Carquinez Strait opposite Southampton Bay. The vertical distribution of zinc in the sediment of these areas is also quite erratic with sample zinc levels ranging from a low of 61-84 ppm to a high of 107-179 ppm. The sediments in these areas are much coarser and hetrogenious than the preceding areas.

The lowest zinc levels were found at the eastern end of the natural channel and on both sides of the entrance to Carquinez Strait. The sediments in these areas are generally the coarsest and most uniformly distributed in the San Pablo Bay-Carquinez Strait area. Correspondingly, the zinc levels are lower with a lesser deviation within holes.

TABLE 16

SAN PABLO BAY-CARQUINEZ STRAIT

MEAN HOLE ZINC CONCENTRATIONS

Rating	Hole	Mean ppm	Range ppm	% Sand $>74\mu$	% Clay $<2\mu$
1.	2D-115(31)	287.0±46.8	236-328	15±21	40±13
2.	2D-116(32)	187.0±3.2	184-190	1±1	49±3
3.	2D-114(33)	164.0±9.1	151-176	15±11	36±8
4.	2D-123(28)	150.4±36.2	89-175	8±4	36±11
5.	2D-119(29)	145.3±47.5	84-197	47±23	19±10
6.	2D-117(35)	139.2±33.5	100-181	9±2	32±6
7.	2D-126(25)	135.0±44.6	86-179	1±1	53±4
8.	2D-125(23)	120.8±37.8	90-175	2±1	53±3
9.	2D-124(27)	112.0±48.6	70-176	34±34	30±18
10.	2D-121(21)	104.9±38.4	63-179	39±33	26±16
11.	2D-118(34)	104.6±18.8	79-136	44±17	17±6
12.	2D-164(15)	98.5±10.1	84-107	62±17	12±5
13.	2D-120(17)	96.3±28.3	65-139	28±16	24±7
14.	2D-128(26)	92.0±21	61-126	37±25	24±11
15.	2D-127(19)	89.7±26.3	73-120	54±16	19±5
16.	2D-122(22)	74.2±12.3	54-86	60±20	15±8
17.	2D-129(24)	69.2±13.6	56-91	70±14	11±7
18.	2D-131(30)	66.7±5.7	62-73	32±33	27±14
19.	2D-132(16)	61.4±25.1	38-99	56±32	21±13
20.	2D-130(20)	59.6±13.4	48-82	73±17	10±7
21.	2D-133(18)	55.4±21.2	44-93	69±16	14±8

Cadmium. The mean cadmium concentration in San Pablo Bay-Carquinez Strait area is 0.75 ± 0.42 ppm. The cadmium concentration in the sediments are highly variable ranging from 0.1 ppm to 1.8 ppm. Table 17 is a listing of the mean hole cadmium concentrations in order of decreasing magnitude. The highest mean hole cadmium concentration (1.57 ± 0.15 ppm) was found at the entrance to Mare Island Strait. The lowest mean hole concentration (0.40 ± 0.21 ppm) was found on the east end of the natural channel. The most variable cadmium concentrations were found in hole 20-118(34) on the south side of the eastern end of Carquinez Strait where the cadmium levels ranged from 0.6 ppm to 1.8 ppm.

Generally, the mean hole cadmium concentrations in Table 17 follow the mean hole sand content. Holes 2D-115(31) and 2D-114(33) have higher zinc levels than would be expected by their sand content. Holes 2D-118(34) and 2D-128(26) also have high mean hole cadmium concentrations. Hole 2D-118(34) with a mean sand content of 44-17 percent has a mean hole cadmium concentration of 1.04 ± 0.34 ppm. The highest sample cadmium concentration in San Pablo Bay-Carquinez Strait area (1.8 ppm) was found in this hole. This sample is located at a depth of 2.5 feet below Bay bottom and has a sand content of 32 percent. Hole 2D-123(28) located on the western end of the southern shallows has extremely low cadmium concentrations when compared to the sand content of the hole (8 ± 4 percent). The surface sample of 2D-123(28) with a sand content of two percent is somewhat enriched with cadmium (0.8 ppm); however, at a depth of 18 feet the sand content is zero and the cadmium level is only 0.4 ppm.

The highest mean hole cadmium concentrations are found in Carquinez Strait, Mare Island Strait, eastern northern and southern shallows, and the north side of the western end of the natural channels. Cadmium levels in Mare Island Strait 2D-116(32) and holes 2D-115(31), 2D-114(33) and 2D-117(35) on the north side of Carquinez Strait are consistently high with concentrations ranging from 1.0 ppm to 1.7 ppm. The surface sampling 2D-128(26) at the northwest end of the natural channel has a cadmium concentration of 1.4 ppm and a sand content of four percent. The two deepest samples (18 to 22 feet below Bay bottom) have a sand content of greater than 50 percent, yet the cadmium levels are 1.0 ppm. These two samples are responsible for the high cadmium rating (#6) for 2D-128(26). Hole 2D-125(23) in the eastern northern shallows of San Pablo Bay has the greatest deviation from the mean cadmium concentration. This is due to the surface sample being enriched with cadmium (1.5 ppm). The deeper samples of 2D-125(23) have cadmium levels between 0.5 ppm and 0.8 ppm. Hole 2D-120(117) in the eastern southern shallows has cadmium levels ranging from 0.5 ppm to 1.1 ppm.

Intermediate mean hole cadmium concentrations with mean hole cadmium concentrations ranging from 0.75 ± 0.1 ppm to 0.53 ± 0.21 ppm were found in the maintained navigation channel, the western end of the

TABLE 17

SAN PABLO-CARQUINEZ STRAIT

MEAN HOLE CADMIUM CONCENTRATIONS

Rating	Hole	Mean ppm	Range ppm	% Sand > 74 μ	% Clay <2 μ
1.	2D-115(31)	1.57±0.15	1.4-1.7	15±21	40±13
2.	2D-114(33)	1.48±0.08	1.4-1.6	15±11	36±8
3.	2D-116(32)	1.47±0.06	1.4-1.5	1±1	49±3
4.	2D-117(35)	1.14±0.11	0.0-1.3	9±2	32±6
5.	2D-118(34)	1.04±0.34	0.6-1.8	44±17	17±6
6.	2D-128(26)	0.97±0.24	0.7-1.4	37±25	24±11
7.	2D-125(23)	0.88±0.43	0.5-1.5	2±1	53±3
8.	2D-120(17)	0.77±0.23	0.5-1.1	28±16	24±7
9.	2D-164(15)	0.75±0.1	0.7-0.9	62±17	12±5
10.	2D-126(25)	0.73±0.34	0.4-1.2	1±1	53±4
11.	2D-127(19)	0.63±0.06	0.6-0.7	54±16	19±5
12.	2D-124(27)	0.62±0.16	0.4-0.8	34±34	30±18
13.	2D-119(29)	0.58±0.21	0.2-0.8	47±23	19±10
14.	2D-133(18)	0.58±0.11	0.5-0.7	69±16	14±8
15.	2D-129(24)	0.54±0.27	0.3-1.0	70±14	11±7
16.	2D-123(28)	0.54±0.15	0.4-0.8	8±4	36±11
17.	2D-131(30)	0.53±0.21	0.3-0.7	32±33	27±14
18.	2D-130(20)	0.46±0.09	0.3-0.5	73±17	10±17
19.	2D-121(21)	0.44±0.18	0.3-0.8	39±33	26±16
20.	2D-132(16)	0.40±0.12	0.3-0.6	56±32	21±13
21.	2D-122(22)	0.40±0.21	0.1-0.6	60±20	15±8

northern and southern shallows, southeast end of the natural channels, and the north and south side of the entrance to Carquinez Strait. Except for holes 2D-126(25) in the western southern shallows and 2D-129(24) on the northeastern side of the natural channel, all sample cadmium levels are less than 1.0 ppm.

The lowest cadmium levels with mean hole concentrations ranging from 0.40±0.21 ppm to 0.46±0.09 ppm were found on the southwestern side of the natural channel and one hole 2D-132(16) on the north side of the entrance to Carquinez Strait.

Copper. The mean copper concentration in San Pablo Bay-Carquinez Strait area is 34.3±15.0 ppm. Copper levels in the sediment range from 11 ppm to 78 ppm. Table 18 is a listing of the mean hole copper concentrations in order of decreasing magnitude. The mean hole copper concentrations range from 16.0±5.3 ppm on the west end of the navigation channel to 61.0±1 ppm in Mare Island Strait.

The highest mean hole copper concentrations are found in Mare Island Strait and north side of Carquinez Strait. The copper levels in holes 2D-116(32), 2D-115(31), 2D-117(35), and 2D-114(33) are uniformly high with the deivation from the mean concentration being less than 12 percent.

Intermediately high mean hole copper concentrations between 34 ppm and 41 ppm were found in the northern and southern shallows of San Pablo Bay, margin of the natural channel (south side), and the furthest hole to the east on the south side of Carquinez Strait. The copper levels in these areas are much more variable than Mare Island Strait and north side of Carquinez Strait. Hole 2D-121(21) on the margin of the natural channel has extremely high copper levels in the surface sediment. The highest sample copper concentration of 78 ppm was found in the surface sample of this hole and is associated with a sand content of 17 percent. At depths greater than ten feet below Bay bottom the sediment abruptly becomes coarser (greater than 60 percent sand) and the copper levels correspondingly decrease to 15 ppm. Holes 2D-125(23) and 2D-126(25) in the northern San Pablo Bay shallows have similar range in copper levels, decreasing from 50 ppm at the surface to 30 ppm at near 15 feet below Bay bottom.

The lowest mean hole copper concentrations are found in the natural and maintained navigation channel in San Pablo Bay and at the entrance to Carquinez Strait. Sample copper concentrations in these areas range from 12 ppm to 41 ppm.

TABLE 18

SAN PABLO BAY-CARQUINEZ STRAIT

MEAN HOLE COPPER CONCENTRATIONS

Rating	Hole	Mean ppm	Range ppm	% Sand >74 μ	% Clay <2 μ
1.	2D-116(32)	61.0±1	60-62	1±1	49±3
2.	2D-115(31)	57.3±7.2	49-62	15±21	40±13
3.	2D-117(35)	51.2±6.8	41-57	9±2	32±6
4.	2D-114(33)	51.0±4.1	43-54	15±11	36±8
5.	2D-121(21)	41.0±23.4	15-78	39±33	26±16
6.	2D-125(23)	39.5±6.6	34-49	2±1	53±3
7.	2D-118(34)	39.1±8.6	28-54	44±17	17±6
8.	2D-123(28)	38.8±18.5	25-71	8±4	36±11
9.	2D-126(25)	37.3±6.9	30-46	1±1	53±4
10.	2D-120(17)	34.2±8.1	24-45	28±16	24±7
11.	2D-131(30)	32.7±12.7	18-41	32±33	27±17
12.	2D-164(15)	31.5±6.0	26-40	62±17	12±5
13.	2D-119(29)	29.7±9.5	13-37	47±23	19±10
14.	2D-132(16)	29.0±19.8	11-60	56±32	21±13
15.	2D-124(27)	27.8±10.3	13-39	34±34	30±18
16.	2D-129(24)	26.6±5.3	20-32	70±14	11±7
17.	2D-122(22)	23.6±3.9	18-27	60±20	15±8
18.	2D-133(18)	22.4±10.7	14-41	69±16	14±8
19.	2D-130(20)	19.2±6.1	12-27	73±17	10±17
20.	2D-128(26)	18.0±4.2	14-26	37±25	24±11
21.	2D-127(19)	16.0±5.3	12-22	54±16	19±5

SUMMARY

Contaminant levels within the San Pablo Bay-Carquinez Strait area vary widely both spatially and temporally. The surface sediments generally have higher legels with most of the nine contaminants. There does not appear to be any discernable pattern in the distribution of contaminants with depth, primarily because of the vast changes in the nature of sediments with depth. There does appear to be a definite relationship between contaminant levels and sediment type (particle size) which is reflected in both the vertical and horizontal distribution of contaminants. However, this relationship is not absolute and other factors such as proximity to the sources of contaminants, rate of shoaling, rate of contaminant input, and association of contaminants to other parameters such as organics and other contaminants most probably play a role in the distribution.

The most distinguishable pattern in levels of contaminants in the San Pablo Bay-Carquinez Strait area can be seen in the spatial distribution of contaminants in the surface sediments (Figures 25-29), especially in San Pablo Bay proper. From the entrance to Carquinez Strait, the contaminant levels increase in a westward direction to a point opposite Pinole Point where the levels begin decreasing toward San Pablo Strait. Moving across San Pablo Bay the contaminant levels are highest in the northern and southern shallows and decrease toward the natural and navigation channel. This pattern of distribution of contaminants closely reflects the current energy environment of the area, and thus, the types of sediment that will be deposited. The coarsest sediments which are generally associated with the lowest contaminant levels in the surface sediments are also associated with the greatest energy of deposition areas. These high energy areas are located in the natural channel and maintained navigation channel of San Pablo Bay proper. Moving towards the flanks of the natural channel and onto the northern and southern shallows the current energy decreases, the sediments become finer and the contaminant levels become greater.

The vertical distribution of contaminants in the San Pablo Bay-Carquinez Strait area is very erratic. Generally, the highest contaminant levels are associated with the finest sediments. Where the sand and clay content of the sediment varies widely with depth, the contaminant levels also vary greatly. The higher contaminant levels in the holes are normally associated with the finer sediments. The vertical distribution of contaminants were compared in terms of the mean hole contaminant concentrations and standard deviations from the mean. This method provided a means of rating the holes as to their relative contaminant levels. The standard deviation from the mean contaminant concentrations provided a method to show how the contaminant levels varied within individual holes. Comparison of mean hole sand content permitted an evaluation of the relationship between particle size and contaminant levels.

Two general trends in the vertical distribution of contaminants become apparent from this method of analysis (Tables 10-18). First, where there is a large deviation from the mean hole sand or clay content, there is also a large deviation from the mean hole contaminant concentration. Second, the contaminant levels are generally associated with the particle size of the sediment. These two trends are related in that the deviation from the mean hole sand or clay content is indicative of the degree of vertical homogenity of the sediment in the hole. Thus, where sediments are uniform with depth the contaminant levels are also uniform or where fine and coarse sediments are inter-bedded, high contaminant levels are associated with the fine sediment and low contaminant levels are associated with coarse sediment.

For discussion purposes the San Pablo Bay-Carquinez Strait area is divided into sub-areas based on geographical location, similarities in physical characteristics of the sediments, and the vertical distribution of contaminants in the sediments. These sub-areas include: Mare Island Strait and the northern shallows of San Pablo Bay; channel margins of Carquinez Strait; southern shallows of San Pablo Bay; entrance to Carquinez Strait; and, the natural and maintained channel in San Pablo Bay.

Mare Island Strait and Northern Shallows of San Pablo Bay

Three holes were drilled in this area: 2D-116(32) in Mare Island Strait, and 2D-125(23) and 2D-126(25) in the northern shallows of San Pablo Bay. Mare Island Strait is characterized as an uniformly low energy environment of deposition. Wind-wave action and current velocities are very low. The sediments are very fine clayey silt and are uniformly distributed with depth. Mare Island Strait experiences very high rates of shoaling. The sediments of the northern shallows of San Pablo Bay are as fine or somewhat finer (silty clay) than in Mare Island Strait. The northern shallows, however, are characterized as a moderate wave-low current energy environment. Like in Mare Island Strait, the fine sediments are uniformly distributed with depth. The northern shallows are normally thought of as a holding area for sediments brought down in suspension from the discharge of the Sacramento-San Joaquin River system. These sediments brought down during the winter season are temporarily deposited in the northern shallows during periods of calm. When wind-wave action increases during the spring and summer months these sediments are resuspended and moved into the natural channel by the slow moving currents, where some are deposited in the natural channel, some are moved back into Carquinez and Mare Island Straits, and some sediments are moved down into Central Bay. Current velocities in the northern shallows are not great enough to transport coarser sediments from the natural channel onto the shallows. Constant wind-wave

action in the spring-summer months and periodically during the winter mix the fine sediments uniformly with depth. The northern shallows area differs from the Mare Island Strait area in that the fine sediments of the northern shallows are constantly worked by wave action, whereas the tranquil conditions in Mare Island Strait does not develop enough energy to disturb the sediments.

Typical distributions of contaminants in Mare Island Strait and the northern shallows of San Pablo Bay are shown in Inclosures 4-38 and 4-27. The sediments of Mare Island Strait and northern shallows of San Pablo Bay, along with the sediments of the north channel margins of Carquinez Strait, have the highest contaminant levels in the San Pablo Bay-Carquinez Strait area. Contaminant levels in sediments of Mare Island Strait are uniformly distributed or slightly increase with depth, whereas contaminant levels in the sediments of the northern shallows of San Pablo Bay generally decrease with depth. On the whole, the sediments of Mare Island Strait have higher contaminant levels than the sediments of the northern shallows of San Pablo Bay. However, volatile solids and oil-grease levels are about the same, and mercury levels in the northern shallows of San Pablo Bay are substantially greater.

Channel Margins of Carquinez Strait

Five holes were drilled in this area; 2D-114(33), 2D-115(31) and 2D-117(35) on the north side of the Strait; and, 2D-118(34) and 2D-119(29) on the south side. The channel margins of Carquinez Strait are characterized as an intermittent current energy and wave energy environment of relatively low magnitude. Sedimentary deposits on the north side of the strait are comprised principally of clayey silt and silty-sandy-clay material, with bedding of a relatively gross nature. On the south side of the strait the sediments are coarser, varying from a sand to silty sand material that is relatively uniformly distributed with depth. The environment of deposition of the south side of the strait has been greater and more uniform than on the northern side of the Strait.

Typical distributions of contaminants in the channel margins of Carquinez Strait are shown on Inclosures 4-37 and 4-41. The contaminant levels along the margins of the strait are exceedingly high when compared to the relatively coarse sediments. Hole 2D-115(31) near the entrance to Mare Island Strait has the highest volatile solids, oil-grease, lead, zinc, cadmium and copper levels found in the San Pablo Bay-Carquinez Strait area. Exceedingly high levels of these contaminants are found even in the coarser silty-sandy-clay surface sediments. There is also a large fluctuation of contaminant levels with depth. Hole 2D-118(34) has the highest levels of chemical oxygen demand and total Kjeldahl nitrogen, even though the sediments are a silty sand and sandy silt material.

Southern Shallows of San Pablo Bay

Three holes were drilled in this area; 2D-120(17), 2D-121(21) and 2D-123(28). The area is characterized as an intermittent current energy and wave energy environment of moderate magnitude. The sediments vary from clayey silt to sandy silt with very gross bedding. These sediments are much coarser than those found in the northern San Pablo Bay shallows and are much more hetrogeneous.

Typical distributions of contaminants in the southern shallows are shown on Inclosures 4-33 and 4-24. Except for chemical oxygen demand, contaminant levels are much lower than in the northern shallows of San Pablo Bay, but are higher and more variable than in the natural channel area.

Entrance to Carquinez Strait

Three holes were drilled in this area; 2D-131(30) on the south side, and 2D-132(16) and 2D-133(18) on the north side of the entrance. The area is characterized as a low wave energy and moderately high current energy environment. The sediments are generally coarse, varying from sand to silt-sand-clay material. Some clayey silt material is present.

Inclosures 4-21 and 4-36 are typical distributions of contaminants at the entrance to Carquinez Strait. The contaminant levels are low and are fairly uniformly distributed with depth.

Natural and Maintained Channel in San Pablo Bay

Seven holes were drilled in this area; 2D-129(24), 2D-130(20), 2D-122(22) and 2D-164(15) on the east end of the natural channel; and, 2D-124(27), 2D-127(19) and 2D-128(26) on the west end. The area is predominantly a current energy environment, decreasing in magnitude towards the west. The sediments on the east end of the natural channel are predominantly sand and silty sand and are fairly uniform with depth. Towards the west end of the natural channel the sediments become finer with greater percentages of silt and clay.

Typical distributions of contaminants in the natural channel are found on Inclosures 4-23 and 4-30. The lowest contaminant levels in the San Pablo Bay-Carquinez Strait area are found in the natural and maintained channel. Contaminant levels are higher at the western end of the channel due to the finer sediments.

SAN PABLO STRAIT-BERKELEY FLATS

DESCRIPTION

The San Pablo Strait-Berkeley Flats area shown on Figure 30 encompasses the major portion of Central San Francisco Bay. The major features of this area are San Pablo Strait connecting San Pablo Bay with Central Bay, Berkeley Flats and Southampton Shoal on the eastern side of Central Bay, San Rafael and Corte Madera Flats on the west side of Central Bay, and Richmond Channel and West Richmond Channel dividing the western shallow areas from the eastern shallow areas.

San Pablo Strait is a 1.6 mile wide natural channel interconnecting San Pablo Bay with Central San Francisco Bay. Powerful currents flowing through this constricted pass have eroded and maintained an elongated scour hole to depths as great as 128 feet below MLLW. The strait is a conduit for transferring and mixing San Pablo Bay brackish water with more saline Central San Francisco Bay water. The submarine configuration of San Pablo Strait is a key geographic feature influencing both tidal hydraulics and current circulation patterns within the Bay system.

Richmond and West Richmond Channels are extensions to San Pablo Strait. Richmond Channel is relatively shallow and narrow compared to West Richmond Channel. Richmond Channel is interrupted by the shallow Southampton Shoal. West Richmond Channel connects the deep water of San Pablo Strait to the deep Central Bay and the Golden Gate. These channels are the major exchange routes of water of North, Central and South San Francisco Bay and the ocean outside the Golden Gate.

Berkeley Flats is a shallow water area consisting of extensive intertidal and subtidal mudflats. Berkeley Flats is within the seven mile long east shore of Central San Francisco Bay bounded by Oakland Outer Harbor Channel in the south and Richmond Harbor Channel in the north. Berkeley Flats (including the Southampton Shoal) encompasses a surface area of about 20 square miles or 5 percent of the total surface area of the Bay system.

Richmond Harbor, an important port and industrial complex, is located in the extreme northern sector of Berkeley Flats. A dredged channel, maintained to a project depth of 35 feet connects deep water in Central Bay to the harbor and port facilities at Richmond.

Southampton Shoal is an elongated shoal, 1.6 miles long with a maximum width of 2,400 feet. The perimeter of the shoal is delimited by the 18-foot contour. The shoal is separated from Berkeley Flats by a

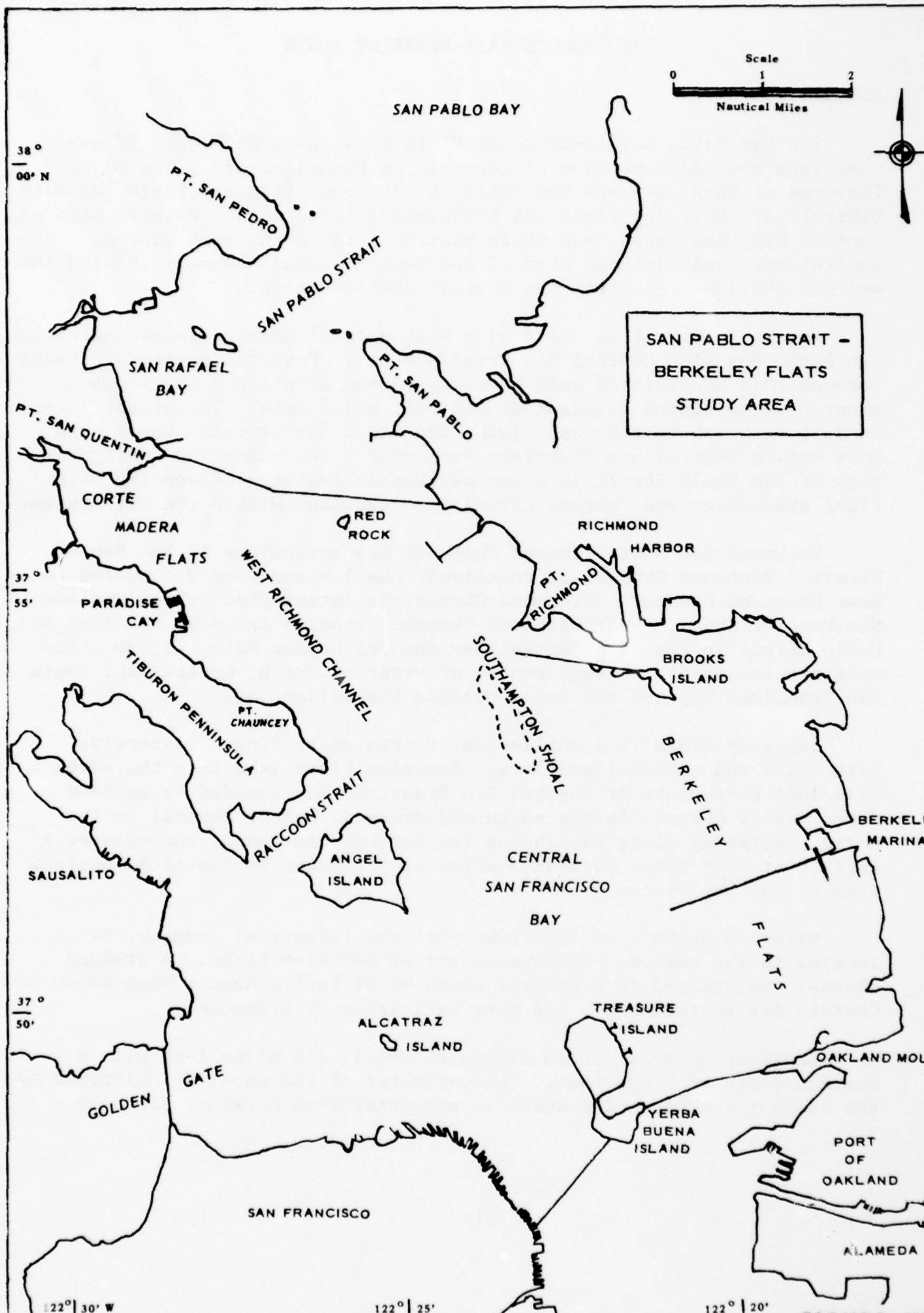

Scale
0
1
2
Nautical Miles
SAN PABLO BAY
38°
00' N
PT. SAN PEDRO
SAN PABLO STRAIT
SAN PABLO STRAIT –
BERKELEY FLATS
STUDY AREA
SAN RAFAEL
BAY
PT. SAN PABLO
PT. SAN QUENTIN
CORTE
MADERA
FLATS
RED
ROCK
RICHMOND
HARBOR
PT.
RICHMOND
37°
55'
PARADISE
CAY
WEST RICHMOND CHANNEL
SOUTHAMPTON SHOAL
BROOKS
ISLAND
TIBURON PENNINSULA
PT.
CHAUNCEY
BERKELEY
RACCOON STRAIT
BERKELEY
MARINA
ANGEL
ISLAND
CENTRAL
SAN FRANCISCO
BAY
SAUSALITO
FLATS
37°
50'
TREASURE
ISLAND
ALCATRAZ
ISLAND
OAKLAND MOLE
GOLDEN
GATE
YERBA
BUENA
ISLAND
PORT
OF
OAKLAND
SAN FRANCISCO
ALAMEDA
122° | 30' W
122° | 25'
122° | 20'

FIGURE 30

moderately deep natural channel. The western perimeter of the shoal is adjacent to the major natural channel in the Bay. A navigation channel maintained to 35 feet below MLLW has been cut through the shoal area. This channel is infrequently dredged because naturally occurring currents scour the channel bed to authorized depths.

Corte Madera and San Rafael Flats form a shallow water area along the western margin of Central San Francisco Bay. These shallow areas are much narrower than the broad Berkeley Flats. These flats are situated in two small sub-bays formed by indentations in the western shore of Central Bay. A major creek empties into each of these small embayments. Navigation channels are dredged in both San Rafael and Corte Madera Creeks to provide depths suitable for navigation by light draft vessels.

Tide and Tidal Currents

Tidal forces are among the primary estuarine processes determining the distribution pattern of bottom sediments in the San Pablo Strait-Berkeley Flats area. Both the vertical and horizontal components of the tide have specific, identifiable effects on sedimentation rates in different parts of the Bay. The vertical rise and fall of the tide in San Pablo Strait and Berkeley Flats area has a mean range of 5.9 feet. This means about 8 square miles of inter-tidal flats are exposed at mean lower low water. The duration of the ebb between HHW and subsequent LLW is greater than any other ebb-flow period of the semi-diurnal tidal cycle. The vertical rise and fall of the tide regulates effective depth of wind-wave action (wave base). Advance and recedence of the tide corresponding with the semi-diurnal tidal fluctuation determines to what extent the bottom sediments are subject to erosion, resuspension and transportaton by wind-wave action.

Tidal current velocities vary with location within the study area, as well as vertically through the water column. Maximum current velocities occur in the deep water channels. In San Pablo Strait flood currents reach maximum velocities of 2.4 knots at the surface and 1.2 knots near the bottom. Ebb currents reach maximum velocities of 3.2 knots at the surface and 1.5 knots near the bottom. Tidal current velocities in the shallow areas such as Berkeley Flats are much less than in the channels and rarely exceed 1.5 knots during the flood or ebb.

Southampton Shoal is a submarine feature formed and maintained by tidal currents. Currents setting over the Shoal are competent enough to winnow away clay and silt size fractions but are too weak to erode fine sands found on the Shoal.

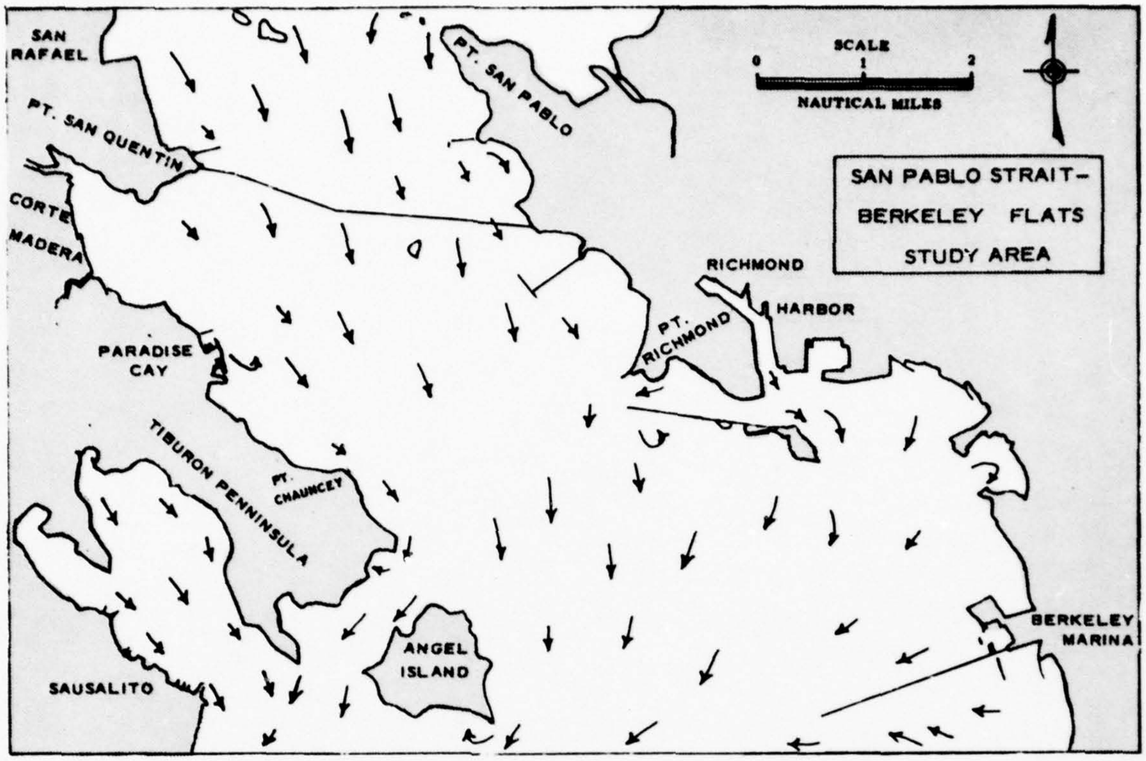
Richmond Harbor navigation channels, turning basins and berthing areas of this port experience low velocity current conditions at all depths. Studies of other harbors within the Bay system indicate a tidal current regimen with tidal prism predominantly filling through the bottom layers of the water column and emptying through the upper surface sections.

Generalized surface flow circulation patterns are shown on Figure 31 for typical flood and ebb tidal conditions during moderate river inflow. Central San Francisco Bay is a mixing zone for two distinct water masses: brackish and fresh water from upstream bays and saline water from the ocean. Turbulent mixing is caused by convergence and divergence of currents, current bed friction, internal shearing across saline and brackish water boundaries and wind and wave action.

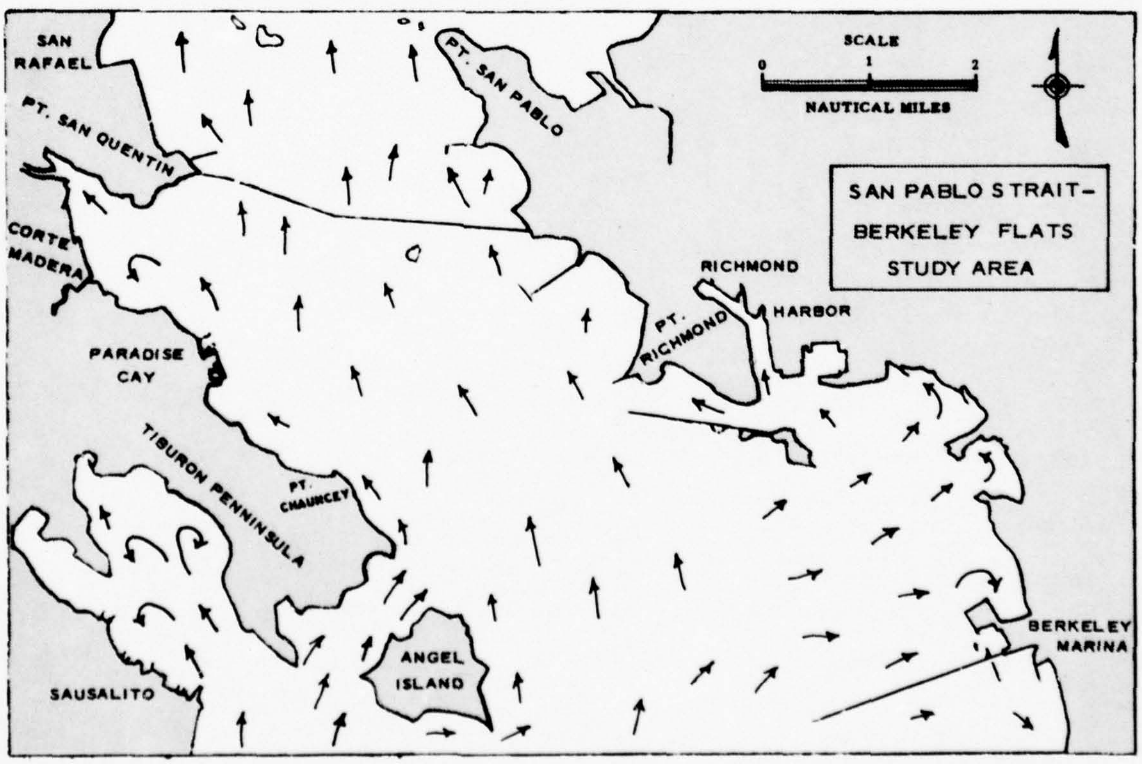
Maximum tidal current velocities in San Pablo Strait occur two hours later than in the southern part of Berkeley Flats and over one hour later than at the Golden Gate. As a consequence of the phasing differences the ebb current in North and Central Bay continues to flow after the tidal current has begun to flood at the Golden Gate and in South Bay. The flood current from the Golden Gate converges with the still ebbing waters in the Berkeley Flats area, driving the ebb flow against the east shore of Central Bay and causing the last stages of the ebb to merge and mix with the flood entering from the Golden Gate and to flow into South Bay. The convergence zone of these two water masses are shown on Figure 32.

Tidal flow is concentrated in the deepwater channels. However, during the initial flood phase, there is a convergence of the east northeast setting flood current with the south setting ebb. The collision effect of this convergence causes eastward displacement of the combined ebb flow and river inflow. This convergence causes the south setting current to meander over the western edge of Berkeley Flats. These current lines (interfaces between distinct surface currents) indicate the location of separate water masses moving south across Berkeley Flats. At later stages of the tidal cycle, during maximum flood, as the flood current sets east over Berkeley Flats it causes setup on the Berkeley shore and a divergence zone develops west of Berkeley Marina. Part of the flood flows north over the flats and alongshore before entering San Pablo Bay. There are small convergence zones near Richmond Inner Harbor and Pt. Richmond. The other portion of the diverging flood sets south over the Flats and alongshore before entering South Bay via the pass between Yerba Buena Island and the Oakland Mole (Toll Plaza).

Ebb currents move south and west over Berkeley Flats. The predominant flow moves west through the gap between Angel Island and Alcatraz Island before leaving the system through the Golden Gate. Some ebb flow from South Bay sets north between the Yerba Buena-Oakland Mole.

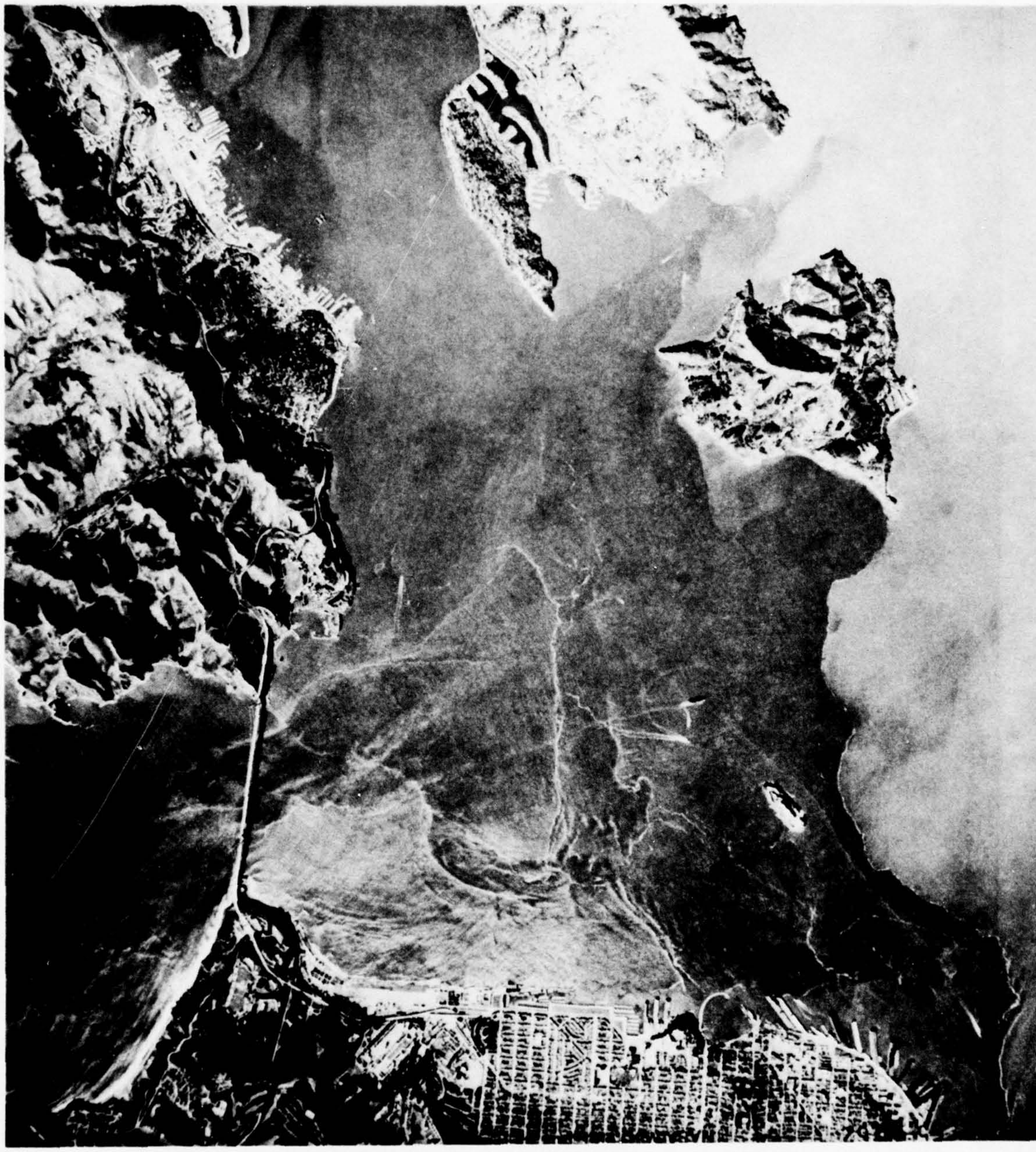


GENERALIZED EBB TIDAL SURFACE CURRENT CIRCULATION PATTERN



GENERALIZED FLOOD TIDAL SURFACE CURRENT CIRCULATION PATTERN

FIGURE 31



Convergence Zone Of Water Masses

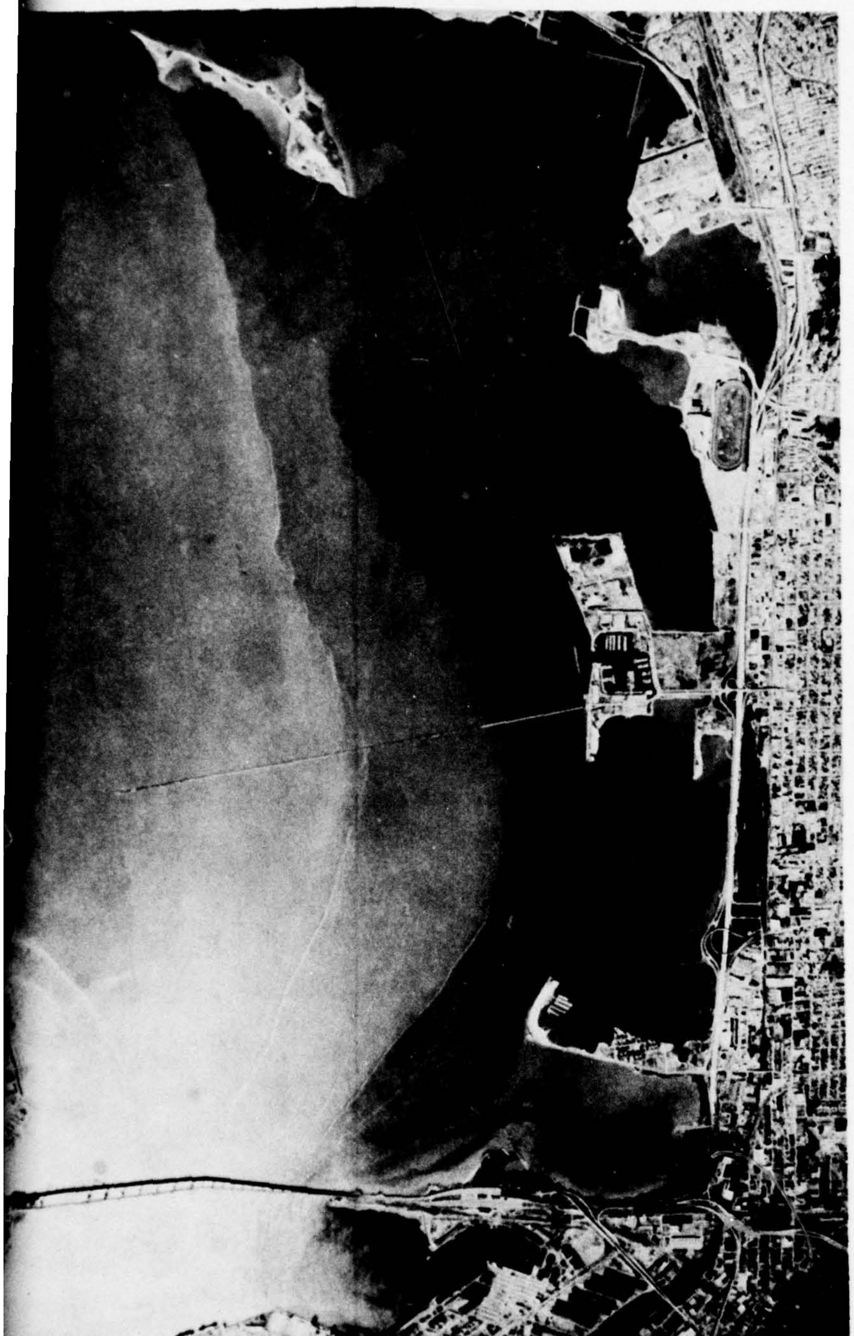


FIGURE 32

2

The main component of the ebb flow from South Bay is funneled north and concentrated on the west side of Yerba Buena Island. Features such as Point Richmond, Brooks Island, Berkeley and Emeryville Yacht Harbors set off low velocity gyres.

Circulation in the study area is multi-level and bidirectional. Density currents due to difference in salinity occur at depth in the channels. The directional predominance of these currents is upstream along the bottom which reinforce flood magnitude and increases flood duration. A difference in salinity of only a few parts per thousand is enough to drive this type of current (Ref. 23). In shallow areas, where the wave base reaches the bottom as is frequently the condition over Berkeley Flats, wind and wave action causes turbulent mixing throughout the water column which destroys salinity gradient and the potential for this type of current.

During winter freshets, salinity currents are highly developed in the deep water channels. Simmons (Ref. 13) describes these sectors of the Bay as well mixed for most of the year but becoming partly mixed with stratified bidirectional flows occurring with flood predominance at the bottom during freshet conditions. Salinity gradient varies directly with freshwater inflow and water column depth.

Wind and Wave Action

Two distinct wind and wave action seasons occur annually in the Bay area. During the spring-summer period, strong, gusty westerly winds are funneled through the Golden Gate onto Berkeley Flats. These prevailing westerlies occur with diurnal regularity. Mornings are generally calm. Winds begin to blow onshore in the late morning increasing in velocity after mid-day and reaching maximum force in mid-afternoon. This pattern with its strong onshore component is controlled by location and intensity of the North Pacific high pressure cell and the smaller low pressure system over the Central Valley.

Waves generated by these summer winds are steep, short period unstable forms. On windy summer afternoons, breaking waves occur over the entire surface area of Berkeley Flats. Waves of three to six feet are known to occur over these shallows. The flats are a high wave energy zone in the Bay. The horizontal surge and turbulent shear forces associated with this wave climate are predominate mechanisms which have formed and maintained the subtidal flats. Prevailing westerly winds drive surface waters downwind and pile these waters onto the Berkeley Flats. These diurnal wind-drift currents transport sediments suspended by wave action shoreward. This onshore flow of water and wind setup generate compensating current movement. These currents manifest themselves in two forms: longshore currents flowing north and south along

the perimeter of the Flats and subsurface currents flowing offshore along the bottom. The longshore component of these currents is greater than the bottom currents because wind action over these shallows tends to retard development of subsurface flow.

The western shoreline of Central Bay is protected from the prevailing westerly winds during the spring and summer months. Wave action in Corte Madera and San Rafael Flats is greatly subdued and wind-wave resuspension of sediments during spring and summer is small in comparison to Berkeley Flats on the eastern shore.

During the winter season, winds are generally offshore with frequent calm periods prevailing. These offshore Santa Ana winds generally blow from the north and northeast. They originate in the high pressure cells situated over the Central Valley of California and the Great Basin area between the Sierra Nevada and Rocky Mountains. These winds develop wind-drift currents moving surface waters of Berkeley Flats offshore. This downwind movement of surface waters triggers a compensating current movement onshore of bottom water layers.

This winter period regimen of offshore winds and calms is interrupted by periodic low-pressure storm systems passing west to east over the Bay. These winter storms generate powerful southerly winds which sweep across the open expanse of Berkeley Flats from South Bay producing sizable waves as well as north setting surface currents. These relatively short duration storms resuspend bottom sediments making them available to be flushed out the Bay by freshet flows. Wave action is also responsible for homogenization of bottom sediments and contaminants, and preferentially winnowing of certain sediment size fractions.

Sediments and Depositional Characteristics

Sediments of the San Pablo Strait-Berkeley Flats area are similar to those found elsewhere in San Francisco Bay. Sediments entering the Bay system undergo a series of temporary stop-overs in Suisun and San Pablo Bays before entering the San Pablo Strait-Berkeley Flats area. The retention time in upstream embayments is controlled by the dynamic forces previously discussed.

Historical sedimentation in Central San Francisco Bay has been described by Smith (Ref. 9). Figure 33 is a contour map of the average annual sediment deposition volume for the years 1855-1948, developed from Smith's data. The highest shoaling rates have occurred along the flanks of the deep water channels in water depths of ten to thirty feet. These areas are located along the fringes of Berkeley Flats on the east side of Central Bay and along the fringes of San Rafael and Corte Madera Flats on the western side. Intermediate shoal areas are adjacent the high shoaling areas in water depths of four to ten feet. Large intermediate shoal areas are located in northern Berkeley Flats, San Rafael

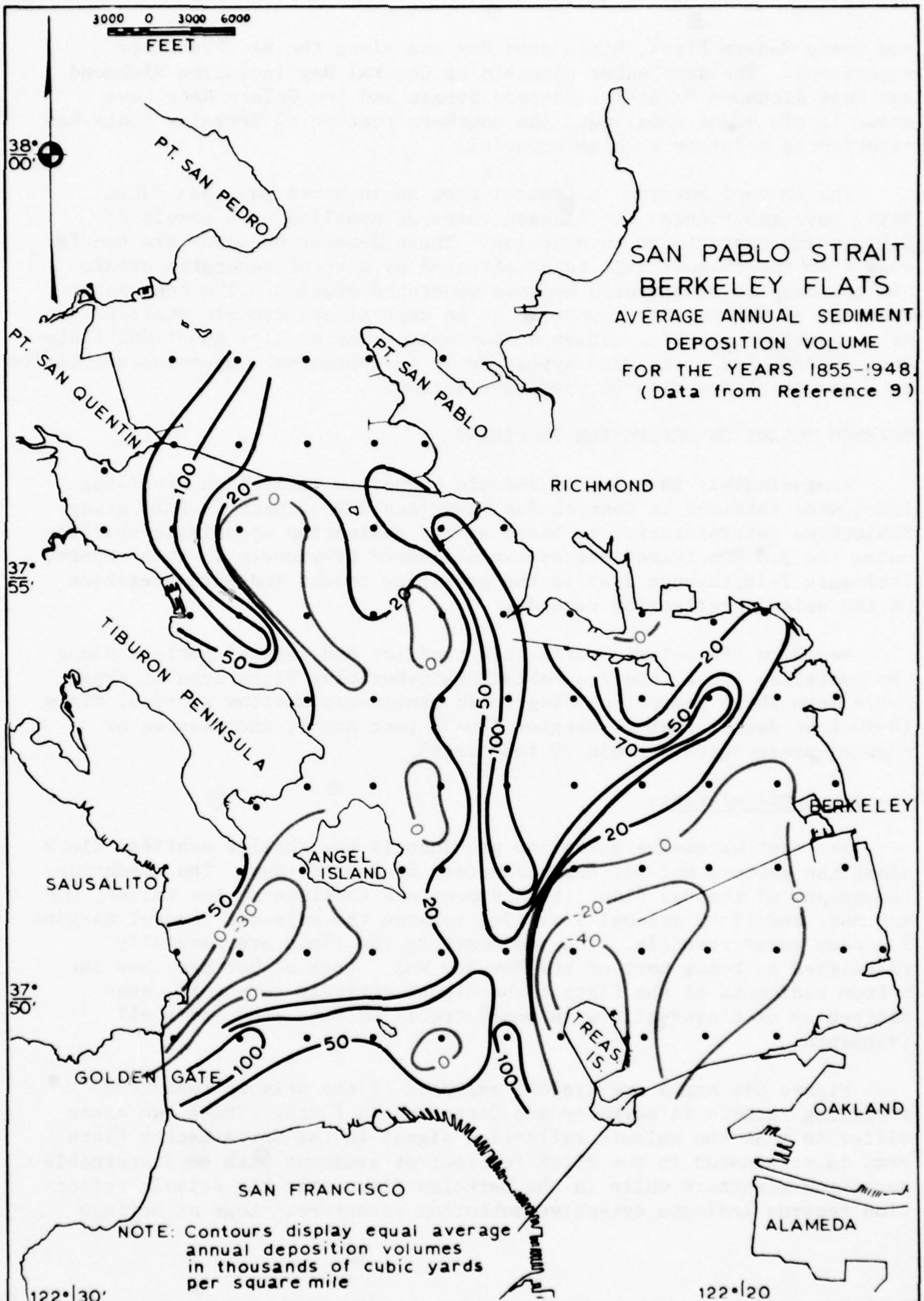

SAN PABLO STRAIT
BERKELEY FLATS
AVERAGE ANNUAL SEDIMENT
DEPOSITION VOLUME
FOR THE YEARS 1855-1948
(Data from Reference 9)
3000 0 3000 6000
FEET
38° 00'
37° 55'
37° 50'
122° 30'
122° 20
PT. SAN PEDRO
PT. SAN QUENTIN
PT. SAN PABLO
RICHMOND
TIBURON PENINSULA
ANGEL ISLAND
SAUSALITO
BERKELEY
TREAS IS.
GOLDEN GATE
OAKLAND
SAN FRANCISCO
ALAMEDA
NOTE: Contours display equal average annual deposition volumes in thousands of cubic yards per square mile

FIGURE 33

and Corte Madera Flats, Richardson Bay and along the San Francisco waterfront. The deep water channels of Central Bay including Richmond and West Richmond Channels, Raccoon Strait and the Golden Gate have shown little or no shoaling. The southern portion of Berkeley Flats has experienced moderate to high scouring.

The channel margins in Central Bay, as in North Bay (San Pablo Bay), have experienced the highest rates of shoaling as a result of diminishing current and wave action. These deposition zones are too far away from the channel axis to be affected by current generated erosion and too deep to be affected by wave generated erosion. The deep water channels of Central Bay appear to be in approximate dynamic equilibrium as a result of scouring action of currents. The shallow sub-tidal flats such as Berkeley Flats also appear to be in approximate dynamic equilibrium as a result of scouring by wind-wave action.

SEISMIC SUBBOTTOM REFLECTION PROFILING

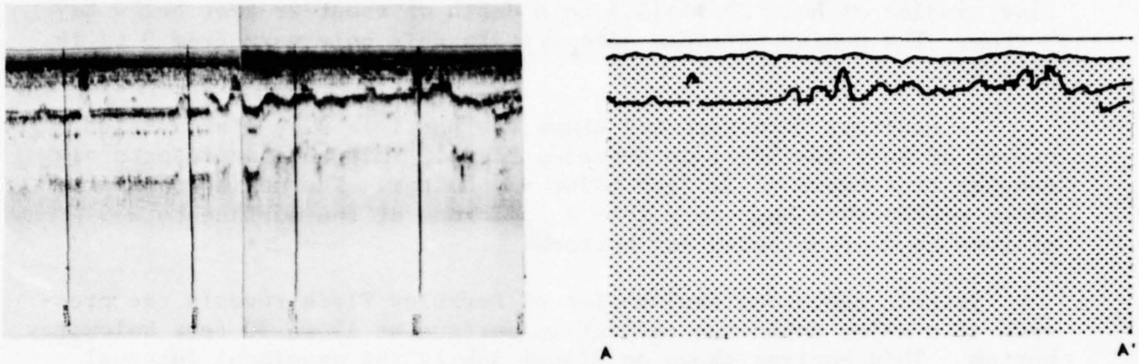
Approximately 66 miles of seismic subbottom reflection profiling lines were obtained in Central San Francisco Bay as part of this study. Subjective interpretation is based on the evaluation of seismic profiles using the 3.5 KHz transducer system discussed previously in this report. Inclosure 2-28 through 2-65 is the profiling tracks and interpretation of the seismic reflection records.

Based on the seismic reflection profiles and logs of borings along the profiling track, the San Pablo Strait-Berkeley Flats area is separated into three general physiographic provinces; shallow subtidal flats (0-10 feet deep), channel margins (10-30 feet deep), and deep water channel areas (greater than 30 feet deep).

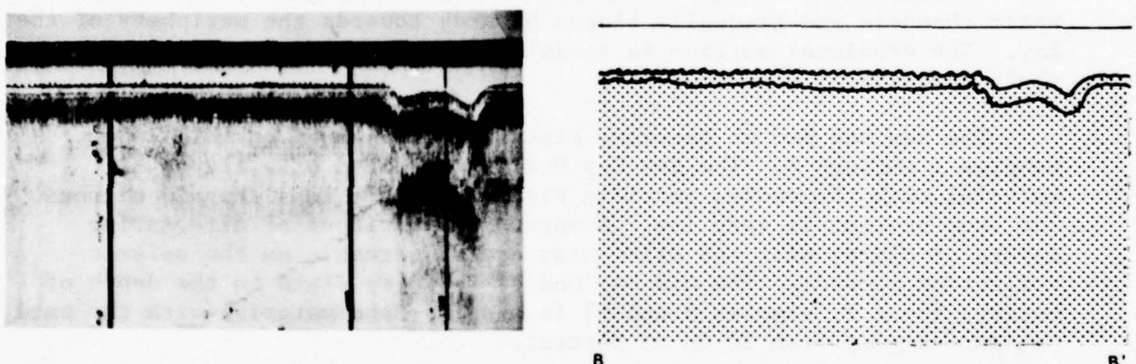
Shallow Subtidal Flats

The most extensive submarine province is the shallow subtidal flats along the eastern and western perimeters of Central Bay. The submarine topography of the Bay floor in this province consists of low relief, mud and mud/sand flats gradually sloping towards the adjacent channel margins and deep water channels. The sediments in the flats are generally classified as being part of the New Bay Mud. Logs of borings show the bottom sediments of the flats to be almost entirely very soft, gray silty-clay or clayey-silt with small traces of fine sand and shell fragments.

Figure 34a and b are typical examples of the seismic subbottom profiling records in Berkeley and Corte Madera Flats. These two areas differ in that the seismic reflection signal in the Corte Madera Flats area is attenuated in the first few feet of sediment with no discernable subbottom structure while in the Berkeley Flats area the seismic reflection records indicate extensive subbottom structure. Logs of borings



A. SHALLOW SUBTIDAL FLATS OFF THE BERKELEY SHORE



B. SHALLOW SUBTIDAL FLATS OFF THE CORTE MADERA SHORE.

FIGURE 34

and mechanical analysis of sediments indicate the Corte Madera Flats area is an uncompacted, dark gray clayey sediment uniformly distributed with depth. Organic material is present in the first three feet of sediment. The particle size distribution curves shown in Inclosure 4-1 are typical of sediments in Corte Madera Flats. The curves represent five samples of hole 2D-144(11) to a depth of about 22 feet below Bay bottom. The median particle sizes within this hole vary from 3 to 16 microns.

In contrast Inclosure 4-7 shows the particle size distribution curves of hole 2D-138(7) in Berkeley Flats. This hole represents six samples to a depth of 21 feet below Bay bottom. The median particle sizes within this hole vary from 4.5 microns at the surface to 250 microns at 21 feet below Bay bottom.

Seismic subbottom exploration of Berkeley Flats reveals the presence of a major subbottom reflection surface at 15 to 30 feet below Bay bottom. This horizon shown on Figure 34b is the erosional interval separating Old Bay Mud from the New Bay Mud. This discontinuity is extensive throughout Central Bay. The seismic reflection records show that the erosional surface is deepest along the margins of the deep water channels and gradually slopes upwards towards the periphery of the Bay. The erosional surface is occasionally interrupted by scattered shell deposits.

The New Bay Mud of Berkeley Flats is represented on hole 7 by samples 1 through 4. The New Bay Mud is comprised of a clayey silt material with the median particle sizes generally less than 20 microns. The sand content is very low. Numerous sub-horizons of alternating layers of clayey silt and silty clay are discernable on the seismic reflection records. The Old Bay Mud of Berkeley Flats to the depth of borings (hole 7, samples 5 and 6) is a silty-sand material with the sand content varying from 30 to 80 percent.

Channel Margins

The channel margins in Central Bay form a transitional zone separating the shallow subtidal flats from the deepwater channels. The submarine topography of the Bay floor in this province is of moderate relief, sloping downward towards the contiguous deepwater channels. The sediments of the channel margins range from a silty clay material in the shallower areas to a silty sand in the deeper areas.

Seismic subbottom reflection profiles show that the channel margins can be further divided into two sub-areas. The first area includes water depths between 10 and 20 feet below MLLW and is characterized on the seismic reflection records as a limited penetration area. On the western side of Central Bay this area is a continuation of the limited

penetration areas of Corte Madera and San Rafael Flats. On the western side of Central Bay the limited penetration area grades into the highly structured subbottom of Berkeley Flats. The right portion of Figure 35 is a typical example of seismic reflection records from water depths between 10 and 20 feet.

The second area of the channel margins ranges generally between 20 and 30 feet below MLLW and is characterized on the seismic reflection records as an area with gross subbottom structure. The left portion of Figure 35 is a typical example of the seismic reflection records from the deeper areas of the channel margins.

The sediments of the upper channel margins are a silty-clay to clayey-silt with median particle sizes rarely exceeding 40 microns. The distribution of sediments with depth is somewhat more variable than the distribution in the subtidal flats. Inclosure 4-13 shows hole 2D-142(12) located in the upper channel margins. The sediments of the lower channel margins are much more variable with depth, ranging from a clayey silt to a silty sand. Inclosure 4-5 shows the particle size distribution curves of hole 2D-141(5) located in the lower channel margins.

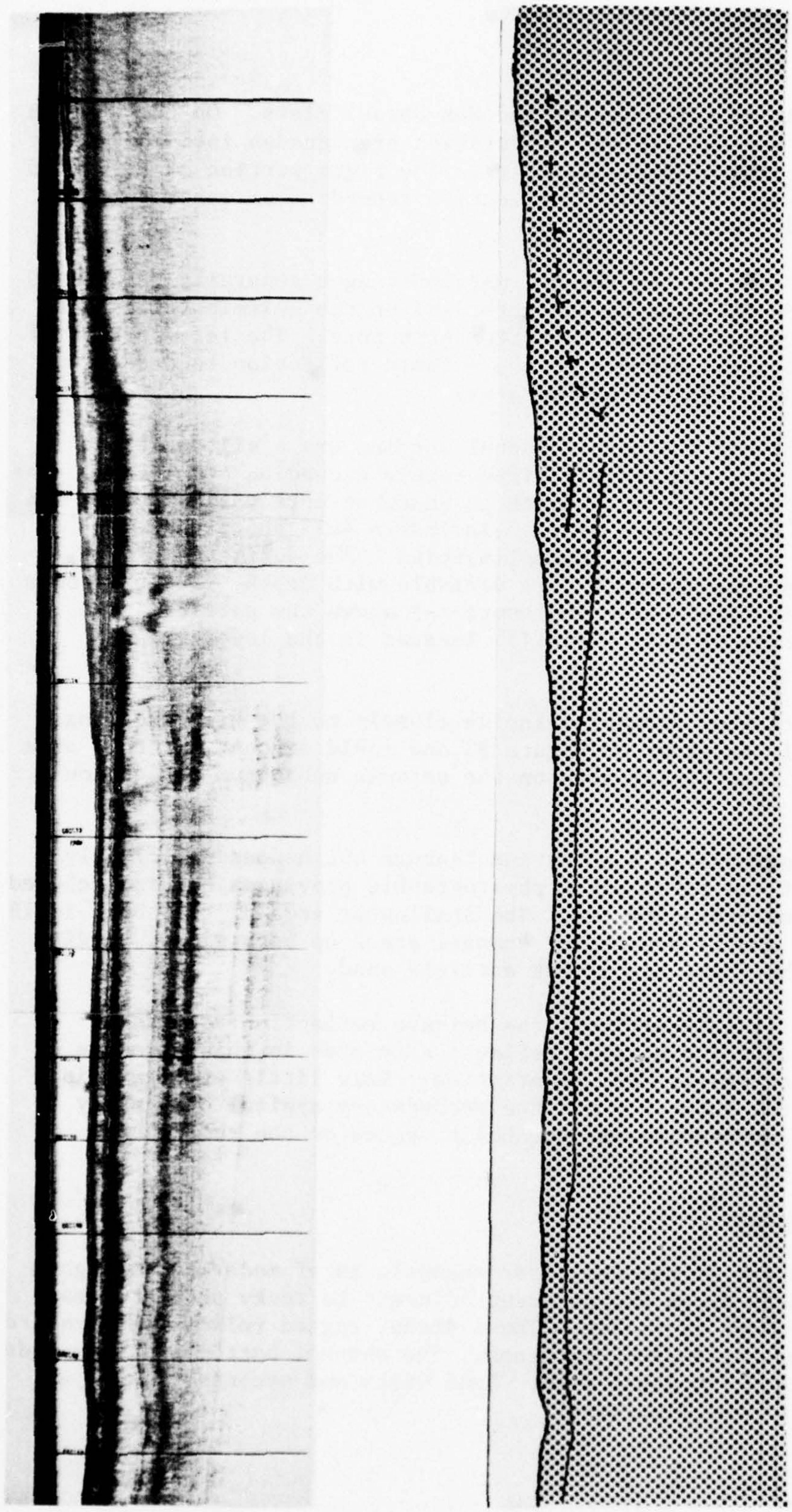
The upper channel margins coincide closely to the high shoaling areas of Central Bay shown on Figure 33 and could account for this area being a limited penetration area on the seismic subbottom reflection profiles.

Southampton Shoal is a submarine feature which does not clearly fall into any of the three major physiographic provinces but is included in the channel margins category. The shallowest area of the shoal is 18 feet below MLLW and is bounded by channel areas on both sides. Sediments forming the shoal are almost entirely sand.

Figure 36a is an example of the seismic reflection records of Southampton Shoal. The seismic reflection records in this area are of good quality with fairly deep penetration. Very little structure is discernible in the subbottom and the records are typical of a sandy bottom, i.e. cross-bedding and parabolic traces on the record as a result of rounded sand particles.

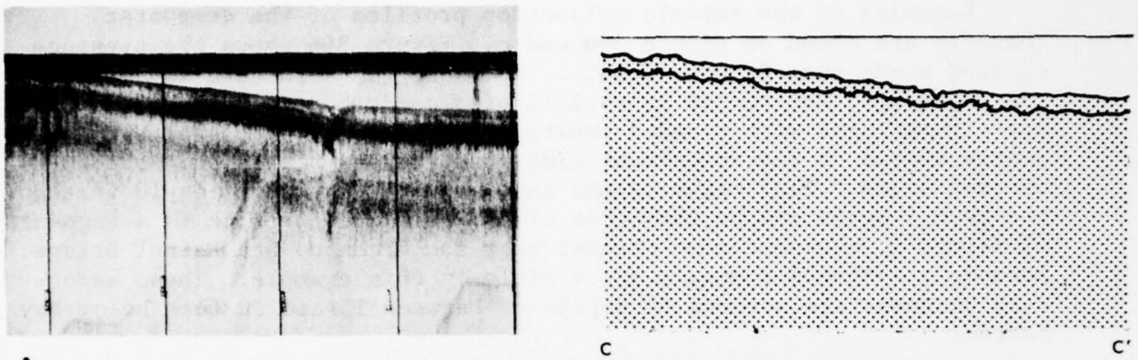
Deep Water Channels

The bathymetry of the deepwater channels is of moderate to high relief. Extremely steep slopes occur adjacent to rocky promontories, islands and offshore pinnacles. These steep, rugged relief features are frequently formed by bedrock outcrops. The channel bottom and some side slopes are principally dense sand. Sand waves and secondary v-shaped channels are frequently present.

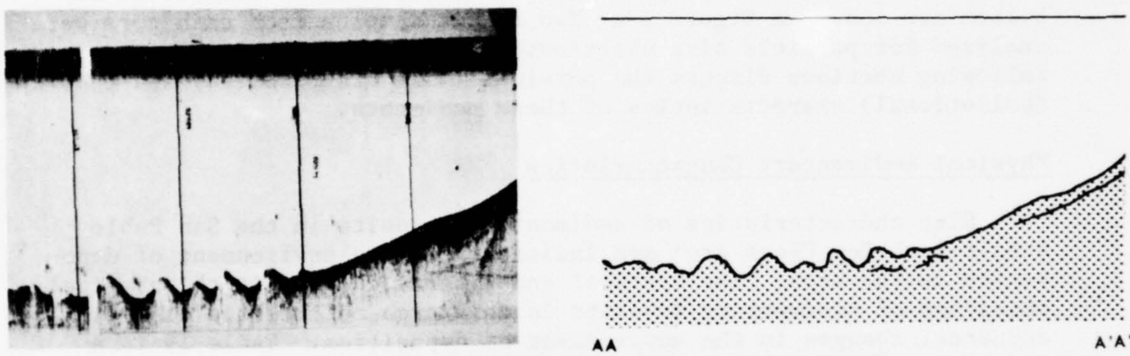


CHANNEL MARGINS - BERKELEY FLATS AREA
H 72-79

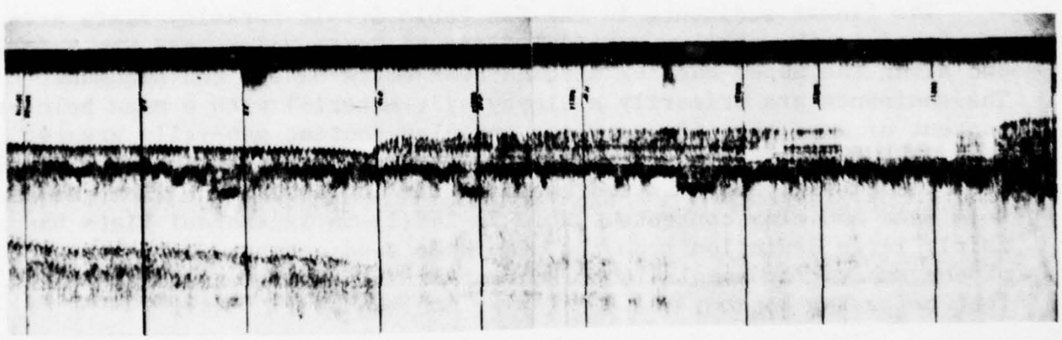
FIGURE 35



A. CHANNEL MARGIN AT SOUTHAMPTON SHOAL.



B. DEEP WATER CHANNEL OFF NE ENTRANCE TO RACCOON STRAIT.



C. WEST RICHMOND CHANNEL E 209-218

FIGURE 36

Examples of the seismic reflection profiles of the deepwater channels are shown on Figure 36b and c. Figure 36b shows the presence of sand waves near Raccoon Strait. No subbottom structure is discernible; however, the record is typical of a sandy bottom. The sand waves are asymmetrical with rounded crests. The ridges of the sand waves have gentle slopes on the up-current sides and steeper slopes on the down-current sides. The height of the sand waves are as great as 10 feet and the wave lengths are on the order of 200 feet. Figure 36c is a segment of record in West Richmond Channel near the Richmond-San Rafael Bridge. Secondary v-shaped channels are visible in this example. These secondary channels are scoured to depths of between 15 and 20 feet below Bay bottom.

CORE SAMPLING AND ANALYSIS

Fourteen holes varying in depth from three to 24 feet below Bay bottom are shown on Figure 17. Two to six samples from each core were analyzed for particle size distribution and the nine contaminants. The following sections discuss the physical (size distribution) and chemical (pollutional) characteristics of these sediments.

Physical Sedimentary Characteristics

Size characteristics of sedimentary deposits in the San Pablo Strait-Berkeley Flats area are indicative of the environment of deposition in the area. The vertical and lateral changes in the physical character of sedimentary deposits in this area reflect the historical and areal changes in the environment of deposition. Table 19 is a listing of the mean hole sand and clay content in order of decreasing clay percentages of core samples taken in the San Pablo Strait-Berkeley Flats area. The mean hole sand content indicates the relative magnitude of the environment of deposition during the history of deposition. The deviation from the mean indicates the degree of uniformity or hetrogeneity of deposits and, thus, the historical changes in input energy.

The finest sediments in the San Pablo Strait-Berkeley Flats area are found in the shallow subtidal flats of Corte Madera and San Rafael and along the upper channel margins near Corte Madera and Richmond. The sediments are primarily a clayey silt material with a mean hole sand content of less than five percent and clay content generally greater than 35 percent. In most cases these fine sediments are very uniformly distributed with depth as indicated by the low deviations from the mean hole sand and clay contents. Hole 2D-148(1) in San Rafael Flats has a fairly large deviation from the mean hole sand content due to the presence of one sandy clay sample (sand content of 15 percent) at about seven feet below Bay bottom.

Holes 2D-137(4) and 2D-135(2) in Berkeley Flats, and 2D-140(9) near the entrance to Richmond Channel are somewhat coarser, less uniformly distributed sediments. The mean sand content in these holes vary from 8 ± 8 percent to 12 ± 4 percent. The sediments can generally be classified as a clayey to sandy silt. The sediments of hole 2D-140(9) are much more uniformly distributed with depth.

TABLE 19

SAN PABLO STRAIT-BERKELEY FLATS
PHYSICAL SEDIMENTARY CHARACTERISTICS

Rating	Hole	Location	% Clay <2 μ	% Sand >74 μ
1	2D-147(6)	Channel Margin-Corte Madera	49±5	2±1
2	2D-142(12)	Channel Margin-Corte Madera	42±7	4±3
3	2D-144(11)	Corte Madera Flats	39±6	3±2
4	2D-148(1)	San Rafael Flats	39±9	5±6
5	2D-143(10)	Channel Margin-Richmond	36±7	4±2
6	2D-137(4)	Berkeley Flats	31±11	8±8
7	2D-140(9)	Channel Margin-Richmond	30±6	12±4
8	2D-138(7)	Berkeley Flats	29±11	23±32
9	2D-145(13)	West Richmond Channel	28±14	29±26
10	2D-136(3)	Berkeley Flats	27±7	3±2
11	2D-141(5)	Channel Margin-Richmond	26±11	36±21
12	2D-135(2)	Berkeley Flats	20±7	11±8
13	2D-146(14)	West Richmond Channel	13±8	68±19
14	2D-139(8)	Southampton Shoal	4±3	90±4

The most variable sediments in the San Pablo Strait-Berkeley Flats are found where the Old Bay Mud deposits have been penetrated and in West Richmond Channel and Richmond Channel. The sand contents of these holes generally increase with depth varying from a clayey, sandy silt in the upper sediment column to a silty sand at depth.

The coarsest sediments are found at holes 2D-146(14) in West Richmond Channel and 2D-139(8) in Southampton Shoal. The sand content in these holes is very high with very little clay or silt.

In summary, the finest sediments in the San Pablo Strait-Berkeley Flats area are found on the more sheltered western side of Central Bay, along the upper channel margins and on the extreme eastern side of Central Bay. The low sand content and general homogeniety of sediments with depth indicate the prevalence of a low energy environment during the geologic time period represented by the depth of borings in these areas. The disruption of the prevailing winds by the hills and ridges of the Marin peninsula diminishes the effective wind generating fetch on the western side of Central Bay, resulting in the reduction of wind-wave action over the shallow subtidal flats. The reduced wave action along

with the low current velocities reduces the resuspension and transport of fine sediments out of the area. The upper channel margins of Central Bay are also fine sediments because they are located at a depth below effective wave action and are removed from the main water flow of the deep water channels for current erosion. The extreme eastern portions of Berkeley Flats are located in an area with a long wind generating fetch, but because of the extensive shallows to the west, the larger waves have already expended their energy before reaching the area. The water circulation along the eastern shore is also too tranquil to erode the fine deposits.

The major portion of Berkeley Flats is slightly coarser sediments than the shallow subtidal flats along the eastern side of Central Bay. The clay content is less and silt content greater due to the wind-wave action. In the Berkeley Flats area the sediments become coarser moving from the eastern shore towards the deep-water channels and is the result of the inability of larger waves to be propagated over the extensive shallow areas. Old Bay Mud deposits are also encountered at depth in Berkeley Flats and are a much coarser silty sand material. The New Bay Mud deposits are alternating layers of clayey and sandy silt. These heterogenious deposits indicate a fluctuating environment of deposition. The fluctuation could be changing wave climate, variations in water depth (subsidnece and/or changing sea level) or modification of the current regimen. The sandy material of the upper Old Bay Mud deposits definately indicates the presence of a strong current energy environment during deposition.

Sediments of the lower channel margins and deep water channels, as well as Southampton Shoal, are almost entirely silty sand sediments indicating a strong current energy environment.

Distribution of Contaminants In Surface Sediments

Surface sediments of the San Pablo Strait-Berkeley Flats area are enriched with all of the nine contaminants. Table 20 is a comparison between the mean contaminant concentration in the surface sediments (0-0.6 feet) and sediments greater than 0.6 feet deep.

Contaminant levels in the surface sediments show a large variation throughout the study area. Figures 37 and 38 give the contaminant concentrations in the surface sediments of each of the 14 holes in San Pablo Strait-Berkeley Flats area.

Zinc concentrations associated with surface sediments range from 53 ppm in West Richmond Channel to 206 ppm in Corte Madera Flats. The highest zinc concentrations in the surface sediments are found in the sheltered shallow subtidal flats of Corte Madera and San Rafael, and the channel margins near Richmond Harbor and Corte Madera. The more exposed subtidal flats of Berkeley have somewhat lower surficial zinc levels, ranging from 80 ppm to 175 ppm. The lowest zinc concentrations in the surface sediments of this area are found in the deep water channels and Southampton Shoal.

TABLE 20

MEAN CONCENTRATION OF CONTAMINANTS IN SURFACE AND SUBSURFACE SEDIMENTS IN SAN PABLO STRAIT-BERKELEY FLATS AREA

Parameter	Mean Concentration (ppm)		% Greater Than
	0-0.6 Feet	Greater Than 0.6 Feet	
Lead	34.71	17.78	49
Zinc	143.50	100.98	30
Mercury	0.77	0.68	12
Cadmium	1.07	0.91	15
Copper	50.79	36.59	28
Oil and Grease	400.0	300.0	25
Volatile Solids $x10^4$	6.41	5.39	16
Chemical Oxygen Demand $x10^4$	3.48	3.43	1
Total Kjeldahl Nitrogen	1000.0	900.0	10

Surface sediment lead concentrations vary from 12 ppm in the deep water channels to 54 ppm in Corte Madera Flats. The highest surface concentrations are found in the sheltered subtidal flats of western Central Bay and the channel margins near Richmond Harbor. The lead concentrations of the more open subtidal flats adjacent to the east shore of Central Bay have somewhat lower lead levels with concentrations varying from 28 ppm to 40 ppm. The lowest lead levels in surface sediments are in West Richmond Channel and Southampton Shoal. The

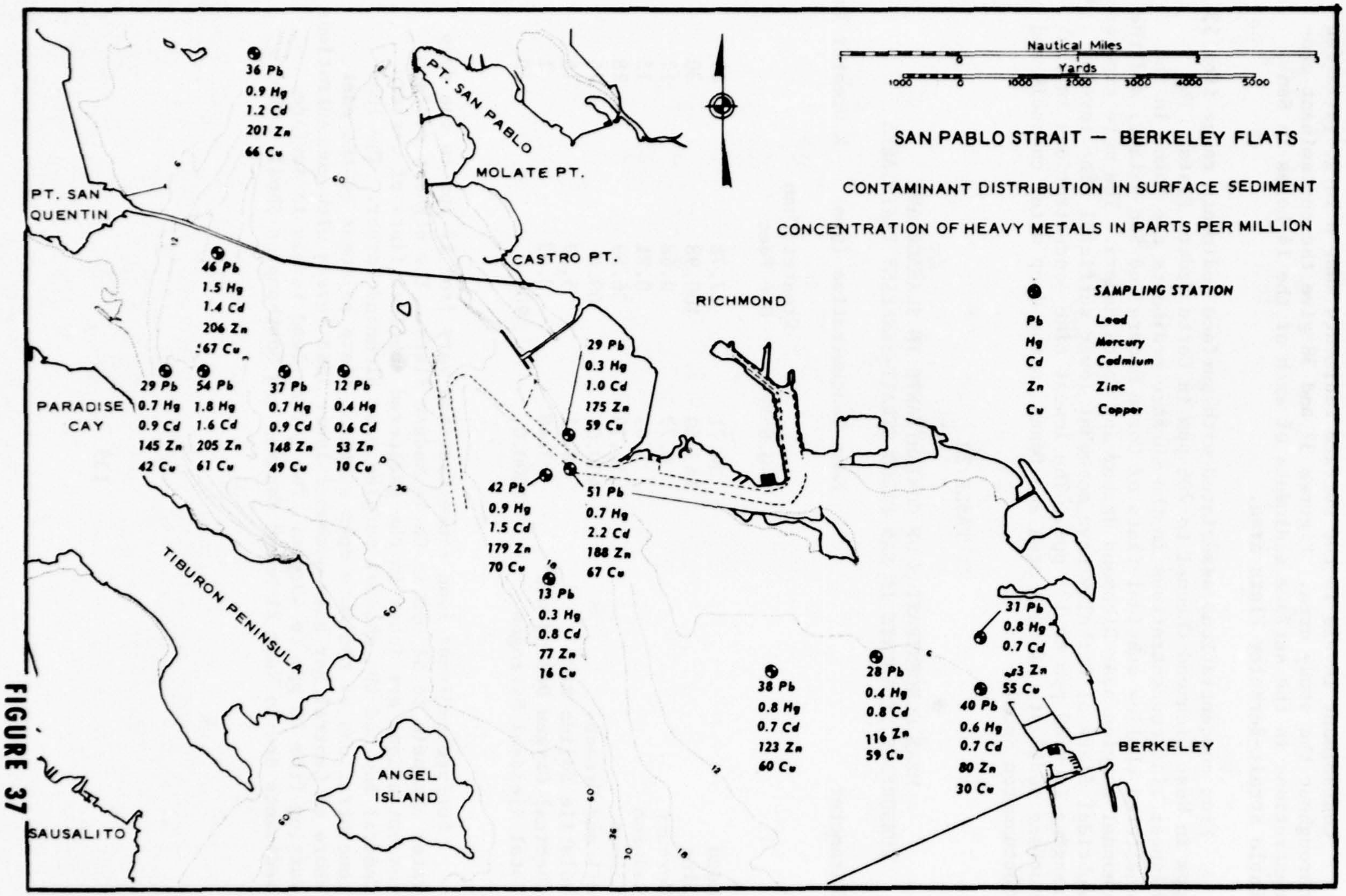

SAN PABLO STRAIT — BERKELEY FLATS
CONTAMINANT DISTRIBUTION IN SURFACE SEDIMENT
CONCENTRATION OF HEAVY METALS IN PARTS PER MILLION
Nautical Miles
Yards
SAMPLING STATION
Pb Lead
Hg Mercury
Cd Cadmium
Zn Zinc
Cu Copper
PT. SAN PABLO
MOLATE PT.
CASTRO PT.
RICHMOND
PT. SAN QUENTIN
PARADISE CAY
TIBURON PENINSULA
ANGEL ISLAND
SAUSALITO
BERKELEY
36 Pb 0.9 Hg 1.2 Cd 201 Zn 66 Cu
46 Pb 1.5 Hg 1.4 Cd 206 Zn 167 Cu
29 Pb 0.7 Hg 0.9 Cd 145 Zn 42 Cu
54 Pb 1.8 Hg 1.6 Cd 205 Zn 61 Cu
37 Pb 0.7 Hg 0.9 Cd 148 Zn 49 Cu
12 Pb 0.4 Hg 0.6 Cd 53 Zn 10 Cu
29 Pb 0.3 Hg 1.0 Cd 175 Zn 59 Cu
42 Pb 0.9 Hg 1.5 Cd 179 Zn 70 Cu
51 Pb 0.7 Hg 2.2 Cd 188 Zn 67 Cu
13 Pb 0.3 Hg 0.8 Cd 77 Zn 16 Cu
38 Pb 0.8 Hg 0.7 Cd 123 Zn 60 Cu
28 Pb 0.4 Hg 0.8 Cd 116 Zn 59 Cu
31 Pb 0.8 Hg 0.7 Cd 63 Zn 55 Cu
40 Pb 0.6 Hg 0.7 Cd 80 Zn 30 Cu

FIGURE 37

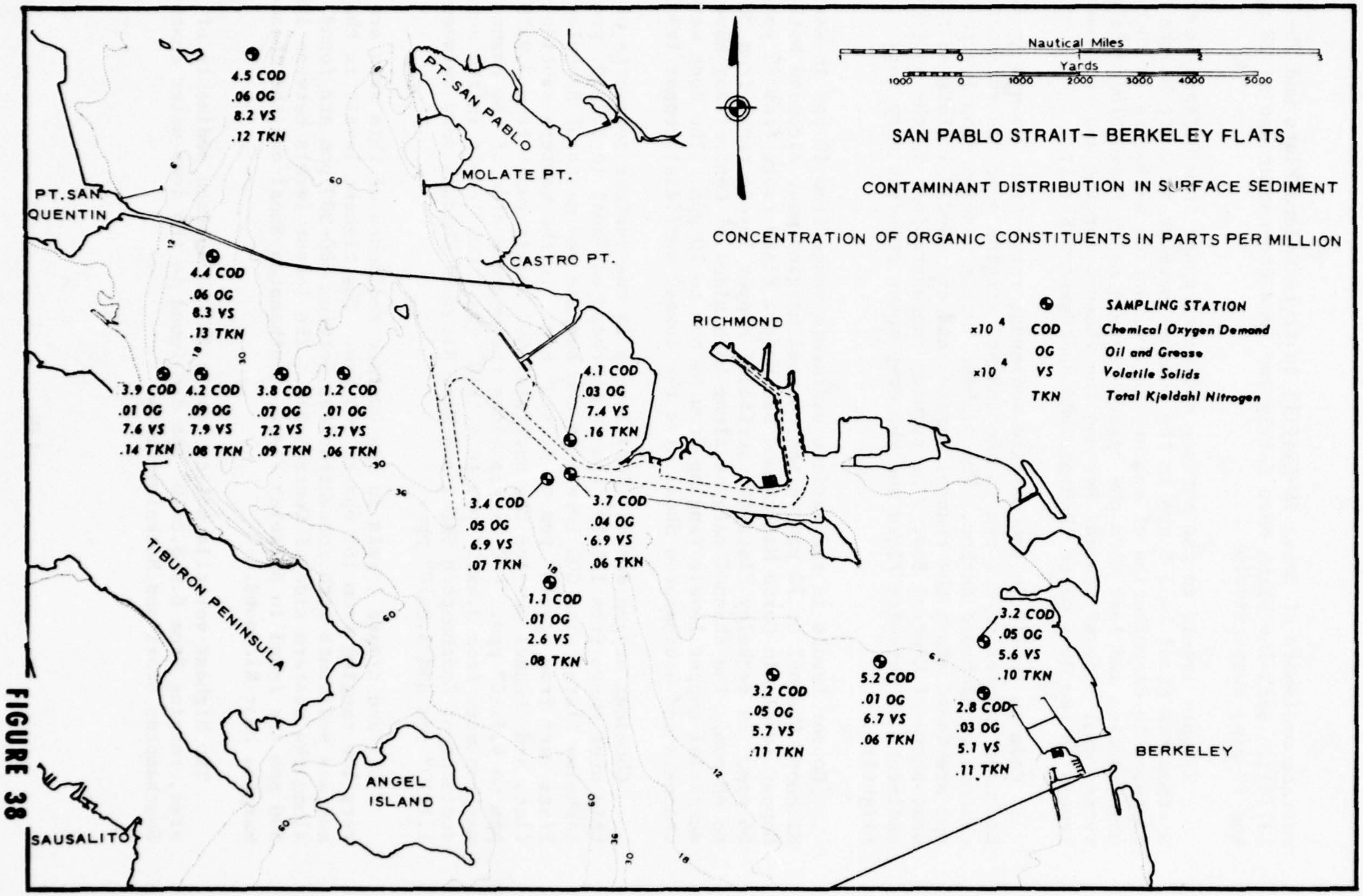

SAN PABLO STRAIT— BERKELEY FLATS
CONTAMINANT DISTRIBUTION IN SURFACE SEDIMENT
CONCENTRATION OF ORGANIC CONSTITUENTS IN PARTS PER MILLION
Nautical Miles
Yards
1000 0 1000 2000 3000 4000 5000
SAMPLING STATION
x10^4 COD Chemical Oxygen Demand
OG Oil and Grease
x10^4 VS Volatile Solids
TKN Total Kjeldahl Nitrogen
PT. SAN PABLO
MOLATE PT.
CASTRO PT.
PT. SAN QUENTIN
RICHMOND
TIBURON PENINSULA
ANGEL ISLAND
SAUSALITO
BERKELEY
4.5 COD .06 OG 8.2 VS .12 TKN
4.4 COD .06 OG 8.3 VS .13 TKN
3.9 COD .01 OG 7.6 VS .14 TKN
4.2 COD .09 OG 7.9 VS .08 TKN
3.8 COD .07 OG 7.2 VS .09 TKN
1.2 COD .01 OG 3.7 VS .06 TKN
4.1 COD .03 OG 7.4 VS .16 TKN
3.4 COD .05 OG 6.9 VS .07 TKN
3.7 COD .04 OG 6.9 VS .06 TKN
1.1 COD .01 OG 2.6 VS .08 TKN
3.2 COD .05 OG 5.7 VS .11 TKN
5.2 COD .01 OG 6.7 VS .06 TKN
3.2 COD .05 OG 5.6 VS .10 TKN
2.8 COD .03 OG 5.1 VS .11 TKN

FIGURE 38

surface sediments of holes 2D-144(11) in Corte Madera Flats and 2D-137(4) in Berkeley Flats have fairly low lead concentrations of 28 ppm and 29 ppm, respectively.

Mercury levels in the surface sediments range from 0.3 ppm in Southampton Shoal to 1.8 ppm in the channel margins of Corte Madera Flats. The distribution of mercury in the surface sediments is much the same as zinc and lead with the highest levels being found along the protected west side of Central Bay and the channel margins and the lowest levels in the deep water channels and Southampton Shoal.

Cadmium levels in the surface sediments range from 0.6 ppm in West Richmond Channel to 2.2 ppm in the channel margins near the entrance channel to Richmond Harbor. The highest levels ranging from 1.2 to 2.2 ppm are found along the channel margins and the subtidal flats on the west shore of Central Bay. The cadmium concentrations in the surface sediments of Berkeley Flats and the deep water channels vary only slightly.

Copper levels in the surface sediments range from 10 ppm in West Richmond Channel to 70 ppm in the channel margins near Richmond Harbor. Copper levels in Corte Madera and San Rafael Flats range from 42 ppm to 66 ppm. In Berkeley Flats the surficial copper levels range from 30 ppm to 60 ppm. The channel margins along both sides of Central Bay have surficial copper levels ranging from 59 ppm to 70 ppm. The deep water channels and Southampton Shoal have the lowest surficial copper levels.

Chemical oxygen demand (COD) levels in the surface sediments of this area range from 1.1×10^4 ppm in Southampton Shoal to 5.2×10^4 ppm in Berkeley Flats. The COD levels in the surface sediments of Berkeley Flats vary from 2.8×10^4 ppm to 5.2×10^4 ppm. In the western subtidal flats and channel margins the surficial COD levels range from 3.9×10^4 ppm to 4.5×10^4 ppm. COD levels along the western side of the channel margins vary from 3.4×10^4 ppm to 4.1×10^4 ppm. COD levels in the surface sediment of Southampton Shoal and West Richmond Channel vary between 1.1×10^4 ppm and 3.8×10^4 ppm.

Oil and grease levels in the surface sediments of this area are very low ranging from 100 ppm to 900 ppm. The highest levels in the surface sediments with concentrations between 600-900 ppm are found along the western side of Central Bay. The lowest levels between 100-500 ppm are found in Berkeley Flats, Southampton Shoal and the channel margins near Richmond.

The highest volatile solids levels in the surface sediments of this area, ranging from $6.9\text{-}8.3 \times 10^4$ ppm are found in the deep water channels, Southampton Shoal and Berkeley Flats.

Total Kjehldahl nitrogen (TKN) levels in the surface sediments of this area range from 1,600 ppm in the channel margins near Richmond to 600 ppm in West Richmond Channel. This highest levels are found in the shallow tubtidal flats of the west side of Central Bay with surfifial concentrations ranging from 1,200-1,400 ppm. On Berkeley Flats the TKN levels in the surface sediments range from 600-1,100 ppm and along the western channel margins and Southampton Shoal TKN levels range from 600 to 1,600 ppm.

On the whole the surface sediments of the western shallow subtidal flats and western channel margins have the highest levels of most of the nine contaminants. These surface sediments are also the finest in the San Pablo Strait-Berkeley Flats area. The surface sediments of the eastern channel margins in and around the entrance channel to Richmond Harbor have the next to highest levels of contaminants, then followed by Berkeley Flats. The lowest levels of the nine contaminants in surface sediments are found in deep water of West Richmond Channel and Southampton Shoal.

Vertical Distribution of Contaminants

Graphs of the vertical distribution of contaminants for the San Pablo Strait-Berkeley Flats area are shown in Inclosure 4-1 through 4-16. Each of the contaminants are discussed in the following paragraphs in terms of mean hole concentrations and deviation from the mean.

Volatile Solids. The mean volatile solids concentration in the San Pablo Strait-Berkeley Flats area is 5.61 $\pm 1.61 \times 10^4$ ppm. The mean is somewhat lower than the San Pablo Bay-Carquinez Strait mean and has a smaller standard deviation. Volatile solids levels in the sediments of this area range from 1.4 -8.3×10^4 ppm. Table 21 is a listing of the mean hole volatile solids concentrations in order of decreasing magnitude.

Mean hole volatile solids concentrations range from 2.30 $\pm 0.4 \times 10^4$ ppm in the sediments of Southampton Shoal to 7.97 $\pm 0.3 \times 10^4$ ppm along the western channel margins. The highest mean hole volatile solids concentrations are found in the western and eastern channel margins, and the western subtidal flats. The sediments in these areas are generally the finest and the most uniformily distributed with depth. Volatile solids levels in these areas are also fairly uniformly distributed with depth.

Hole 2D-147(6) located near the San Rafael-Richmond Bridge along the western channel margins has the highest mean hole concentration of 7.97 $\pm$0.3x10^4 ppm. This hole has the lowest sand content (2$\pm$1 percent) and highest clay content (49$\pm$5 percent) of all the holes in the San Pablo Strait-Berkeley Flats area. Sample concentrations decrease from 8.3x10^4 ppm in the surface sediments to 7.7x10^4 ppm at about 15 feet below Bay bottom.

TABLE 21

SAN PABLO STRAIT-BERKELEY FLATS
MEAN HOLE VOLATILE SOLIDS CONCENTRATIONS

Rating	Hole	Mean ppm x 10^4	Range ppm x 10^4	% Sand >74 μ	% Clay <2 μ
1	2D-147(6)	7.97$\pm$0.3	7.7-8.3	2$\pm$1	49$\pm$5
2	2D-148(1)	7.12$\pm$1.0	5.8-8.2	5$\pm$6	39$\pm$9
3	2D-142(12)	7.10$\pm$0.9	5.9-7.9	4$\pm$3	42$\pm$7
4	2D-143(10)	6.86$\pm$0.6	6.1-7.5	4$\pm$2	36$\pm$7
5	2D-144(11)	6.72$\pm$0.9	5.7-7.6	3$\pm$2	39$\pm$6
6	2D-140(9)	5.78$\pm$0.9	5.1-6.9	12$\pm$4	30$\pm$6
7	2D-145(13)	5.68$\pm$1.5	3.7-7.2	29$\pm$26	28$\pm$14
8	2D-137(4)	5.26$\pm$1.3	3.6-6.7	8$\pm$8	31$\pm$11
9	2D-141(5)	4.96$\pm$1.1	4.3-6.9	36$\pm$21	26$\pm$11
10	2D-138(7)	4.83$\pm$1.9	4.8-7.0	23$\pm$32	29$\pm$11
11	2D-135(2)	4.48$\pm$0.7	3.5-5.1	11$\pm$8	20$\pm$7
12	2D-136(3)	4.32$\pm$0.8	3.6-5.6	3$\pm$2	27$\pm$7
13	2D-146(14)	4.10$\pm$0.7	3.7-5.4	68$\pm$19	13$\pm$8
14	2D-139(8)	2.30$\pm$0.4	2.0-2.6	90$\pm$4	4$\pm$3

The most variable volatile solids levels are found in holes 2D-145(13) in West Richmond Channel, 2D-137(4) and 2D-138(7) in Berkeley Flats, and 2D-141(5) in the deeper channel margins near Richmond Harbor. For example, hole 2D-145(13) has a mean hole sand and clay content of 29$\pm$26 percent and 28$\pm$14 percent, respectively. The upper five feet of sediment of this hole is a clayey silt material with volatile solids levels greater than 7.0x10^4 ppm. From five to ten feet below Bay bottom the sediment varies from a sandy silt to silty sand material with volatile solids levels ranging from 3.7 to 5.7x10^4 ppm. The volatile solids levels of 2D-141(5) in the deeper portion of the channel margins near Richmond Harbor decrease with depth despite the particle size variability with depth. The large deviation from the mean hole volatile solids concentration in 2D-138(7) is due to the variability in volatile solids levels of the New and Old Bay Mud. The volatile solids levels in the New Bay Mud to a depth of about 15 feet below Bay bottom range from 4.8 to 5.7x10^4 ppm. The sand content of the New Bay Mud deposits in this

hole varies from 4 to 9 percent. The sand content of the Old Bay Mud between 15 and 20 feet varies between 28 and 85 percent. The volatile solids range from 1.4 to 7.0×10^4 ppm in the Old Bay Mud.

In comparison to other locations in this area, holes 2D-135(2) and 2D-136(3) have low mean hole volatile solids concentrations for the relatively fine sediments found in these holes. The sand content of 2D-136(3) varies between 0 and 5 percent, yet the volatile solids levels are among the lowest found in the San Pablo Strait-Berkeley Flats area. The clay content of these holes are also fairly low with a correspondingly high silt contents.

The lowest mean hole volatile solids concentrations are found at holes 2D-146(14) in West Richmond Channel and 2D-139(18) in Southampton Shoal. These sediments are also the coarsest sediments in the San Pablo Strait-Berkeley Flats area. Volatile solids levels in 2D-146(14) vary between 3.7×10^4 ppm and 3.9×10^4 ppm with the exception of one sample at seven feet below Bay bottom which has a volatile solids concentration of 5.4×10^4 ppm. The sand content of this sample is 78 percent.

Chemical Oxygen Demand. The mean chemical oxygen demand (COD) in the San Pablo Strait-Berkeley Flats area is $3.44 \pm 1.0 \times 10^4$ ppm. The mean in this area is slightly greater than the San Pablo Bay-Carquinez Strait mean; however, the variability in COD concentrations throughout the San Pablo Strait-Berkeley Flats area is much less. The COD concentrations in the sediments of this area range from 0.7×10^4 ppm to 5.2×10^4 ppm. Table 22 is a listing of the mean hole COD concentrations in order of decreasing magnitude.

The highest mean hole COD concentration is found at 2D-147(6) along the upper channel margins of Corte Madera. COD concentrations in this hole are very uniformly distributed, ranging from 3.9 to 4.4×10^4 ppm. Sediments of this hole are very fine and are also very uniformly distributed with depth. The lowest mean hole COD concentrations are found in hole 2D-139(8) on Southampton Shoal. Mean hole concentrations in 2D-146(14) and 2D-139(8) are $2.04 \pm 0.6 \times 10^4$ and $0.90 \pm 0.3 \times 10^4$ ppm, respectively. There is very little variability in the mean hole COD concentrations in the remainder of the holes in the San Pablo Strait-Berkeley Flats area. In these holes the mean COD concentrations range from $3.23 \pm 0.3 \times 10^4$ ppm to $3.98 \pm 1.0 \times 10^4$ ppm.

TABLE 22

SAN PABLO STRAIT-BERKELEY FLATS
MEAN HOLE CHEMICAL OXYGEN DEMAND

Rating	Hole	Mean ppm x 10^4	Range ppm x 10^4	% Sand > 74 μ	% Clay <2 μ
1	2D-146(6)	4.17±0.3	3.9-4.4	12±1	49±5
2	2D-140(9)	3.98±1.0	2.5-5.0	12±1	30±6
3	2D-145(13)	3.93±0.7	3.2-5.2	29±26	28±14
4	2D-142(12)	3.90±0.5	3.1-4.2	4±3	42±7
5	2D-144(11)	3.76±0.4	3.1-4.2	3±2	39±6
6	2D-137(6)	3.74±1.0	2.7-5.2	8±8	31±11
7	2D-138(7)	3.57±1.5	0.8-4.5	23±32	29±11
8	2D-136(3)	3.54±0.4	4.0-3.2	3±2	27±7
9	2D-143(10)	3.40±0.6	2.6-4.1	4±2	36±7
10	2D-141(5)	3.38±0.9	2.0-4.5	36±21	26±11
11	2D-148(1)	3.34±1.1	2.3-4.6	5±6	39±9
12	2D-135(2)	3.23±0.3	2.8-3.6	11±8	20±7
13	2D-146(14)	2.04±0.6	1.2-2.7	68±19	13±8
14	2D-139(8)	0.90±0.3	0.7-1.1	90±4	4±3

Total Kjeldahl Nitrogen. The mean total Kjeldahl nitrogen (TKN) concentration in the San Pablo Strait-Berkeley Flats area is 1,000±300 ppm. This mean concentration is somewhat lower than the San Pablo Bay-Carquinez Strait mean and the variability of TKN levels in the sediments is much less. TKN levels in the sediments of this area range from 400 ppm to 1,600 ppm. Table 23 is a listing of the mean hole TKN concentrations in order of decreasing magnitude.

Mean hole TKN concentrations range from 1,300±300 ppm in sediments of Corte Madera Flats to 600±100 in West Richmond Channel. The highest mean hole concentrations are found along the upper channel margins and shallow subtidal flats along the western side of Central Bay. The lowest mean hole TKN concentrations are found in Berkeley Flats, West Richmond Channel and Southampton Shoal.

TABLE 23

SAN PABLO STRAIT-BERKELEY FLATS
MEAN HOLE TOTAL KJELDAHL NITROGEN CONCENTRATIONS

Rating	Hole	Mean ppm	Range ppm	% Sand > 74 μ	% Clay <2 μ
1	2D-144(11)	1300±300	1000-1600	3±2	39±6
2	2D-143(10)	1200±200	1000-1600	4±2	36±7
3	2D-147(6)	1200±100	1100-1300	2±1	49±5
4	2D-135(2)	1100	1000-1100	11±8	20±7
5	2D-148(1)	1100±300	700-1600	5±6	39±9
6	2D-142(12)	1000±400	600-1600	4±3	42±7
7	2D-140(9)	1000±300	600-1200	12±4	30±6
8	2D-145(6)	1000±200	800-1200	29±26	28±14
9	2D-138(7)	900±300	500-1100	23±32	29±11
10	2D-136(3)	800±200	600-1100	3±2	27±7
11	2D-137(4)	700±300	400-1100	8±8	31±11
12	2D-141(5)	700±300	700-100	36±21	26±11
13	2D-139(8)	700±100	600-800	90±4	4±3
14	2D-146(14)	600±100	400-800	68±19	13±8

Oil and Grease. The mean oil-grease concentration in the San Pablo Strait-Berkeley Flats area is 400±300 ppm. Oil-grease levels are smaller and of less variability than in San Pablo Bay-Carquinez Strait. Oil-grease concentrations in the sediments range from 400-1600 ppm. Table 24 is a listing of the mean hole oil-grease concentrations in order of decreasing magnitude.

All mean hole oil-grease concentrations are less than 1000 ppm and only in a few cases do individual samples exceed this value. The highest mean hole concentrations are associated with holes having the finest sediments, namely, along the upper channel margins and shallow subtidal flats of the western shore of Central Bay. The lowest mean hole oil-grease concentrations are found in West Richmond Channel and Southampton Shoal.

TABLE 24

SAN PABLO BAY-BERKELEY FLATS
MEAN HOLE OIL-GREASE CONCENTRATIONS

Rating	Hole	Mean ppm	Range ppm	% Sand >74 μ	% Clay <2 μ
1	2D-142(12)	900±500	500-900	4±3	42±7
2	2D-147(6)	700±100	600-800	2±1	49±5
3	2D-144(11)	600±500	100-1400	3±2	39±6
4	2D-148(1)	600±300	100-900	5±6	39±9
5	2D-145(13)	400±200	100-700	29±26	28±14
6	2D-143(10)	400±100	300-600	4±2	36±7
7	2D-140(9)	300±100	200-400	12±4	30±6
8	2D-135(2)	300±100	100-300	11±8	20±7
9	2D-136(3)	200±200	100-500	3±2	27±7
10	2D-138(7)	200±200	100-500	23±32	29±11
11	2D-141(5)	200±200	100-500	36±21	26±11
12	2D-137(4)	100	100-100	8±8	31±11
13	2D-139(8)	100	100-100	90±4	4±3
14	2D-146(14)	100±100	100-30	68±19	13±8

Mercury. The mean mercury concentration in San Pablo Strait-Berkeley Flats area is 0.70±0.36 ppm. This mean concentration is somewhat lower than mean mercury level in San Pablo Bay-Carquinez Strait. San Pablo Strait-Berkeley Flats bottom sediments have mean hole mercury concentrations ranging from 1.28±0.67 ppm in the western channel margins to 0.30 ppm in Southampton Shoal. Table 25 lists mean hole mercury concentrations in order of decreasing magnitude.

The highest mean hole mercury concentrations in San Pablo Strait-Berkeley Flats are found in 2D-142(12) with a concentration of 1.28±0.67 ppm and 2D-147(6) with a concentration of 1.23±0.46 ppm. These holes are located along the western channel margins of Central Bay. Sediments in these holes are classified as silty clay and clayey silt with very little sand. Both holes have a mean hole clay content greater than 40 percent and sand content of less than four percent. Mercury levels in 2D-142(12) decrease with depth from 1.8 ppm in surface sediment to 0.6 ppm 16 feet below the Bay bottom. The highest mercury value, 1.9 ppm, of all samples analyzed from San Pablo Strait-Berkeley Flats was taken from this hole. Mercury levels in 2D-147(6) also decrease with depth from 1.5 ppm in the surface sediment to 0.7 ppm at minus 15 feet.

TABLE 25

SAN PABLO STRAIT-BERKELEY FLATS
MEAN HOLE MERCURY CONCENTRATIONS

Rating	Hole	Mean ppm	Range ppm	% Sand >74 μ	% Clay <2 μ
1	2D-142(12)	1.28±0.67	0.6-1.9	4±3	42±7
2	2D-147(6)	1.23±0.46	0.7-1.5	2±1	49±5
3	2D-136(3)	0.78±0.43	0.4-1.5	3±2	27±7
4	2D-145(13)	0.75±0.34	0.4-1.4	29±26	28±14
5	2D-144(11)	0.74±0.33	0.5-1.3	3±2	39±6
6	2D-140(9)	0.68±0.18	0.4-0.9	12±4	30±6
7	2D-137(4)	0.66±0.26	0.4-0.8	3±2	27±7
8	2D-143(10)	0.64±0.24	0.3-0.9	4±2	36±7
9	2D-148(1)	0.64±0.21	0.4-0.9	5±6	39±9
10	2D-138(7)	0.63±0.22	0.3-0.9	23±32	29±11
11	2D-141(5)	0.54±0.23	0.3-0.9	36±21	26±11
12	2D-135(2)	0.53±0.15	0.4-0.7	11±8	20±7
13	2D-146(14)	0.46±0.13	0.4-0.7	68±19	13±8
14	2D-139(8)	0.30	0.3-0.3	90±4	4±3

The greatest variability in mercury concentration levels is also found in 2D-142(12) and 2D-147(6) with standard deviations of ±0.67 ppm and ±0.46 ppm, respectively. Sediments in these holes are clayey-silts and silty clays uniformly distributed with depth. Clay content in these holes decreases with depth. 2D-142(12) sediments range from 47 percent clay at the surface of the Bay bottom to 31 percent 16 feet below the Bay bottom. Corresponding mercury values range from 1.8 ppm to 0.6 ppm. Hole 2D-147(6) shows a similar distribution pattern of sediment size and mercury values. The large deviation from the mean mercury concentration in these two holes is caused by very high concentrations in surface sediments decreasing to much lower levels with depth.

The lowest mean hole mercury concentrations are from holes 2D-139(8) located in Southampton Shoal and 2D-146(14) siutated in West Richmond Channel. Mean hole mercury levels for 2D-146(14) and 2D-139(8) are 0.46±0.3 ppm and 0.30 ppm.

Mercury concentration in 2D-146(14) is 0.4 ppm in the uppermost 8 feet of this hole. The deepest sample taken from this hole at minus 14 feet had a mercury concentration of 0.7 ppm. Sediments in these holes are almost entirely fine sand.

Lead. The mean lead concentration in the San Pablo Strait-Berkeley Flats area is 22±9 ppm, about 40 percent lower than the mean lead concentration of the San Pablo Bay-Carquinez Strait area. Mean hole lead concentrations associated with San Pablo Strait-Berkeley Flats sediments range from 11 to 37 ppm. Table 26 shows the mean hole lead concentrations in order of decreasing magnitude.

Mean hole lead concentrations associated with sediments in San Pablo Strait-Berkeley Flats range from 11 ppm in the deep water channel area of Central Bay to 54 ppm in the western channel margins. Holes with the highest mean hole lead concentrations are located in the western channel margins where the sediments are predominantly a clayey silt material with moderately uniform distribution with depth.

Holes 2D-142(12) and 2D-147(6) situated in the western channel margins have the highest mean hole lead concentrations of 36.5±13.8 ppm and 34.7±9.9 ppm, respectively.

Lead concentrations in 2D-142(12) decrease from 54 ppm in the surface sediment to 22 ppm at about 16 feet below Bay bottom.

TABLE 26

SAN PABLO STRAIT-BERKELEY FLATS
MEAN HOLE LEAD CONCENTRATIONS

Rating	Hole	Mean ppm	Range ppm	% Sand >74 μ	% Clay <2 μ
1	2D-142(12)	36.5±13.8	22-54	4±3	42±7
2	2D-147(6)	34.7±9.9	30-46	2±1	49±5
3	2D-144(11)	25.8±4.6	19-31	3±2	39±6
4	2D-148(1)	25.4±9.2	18-36	5±6	39±9
5	2D-140(9)	25.2±15.1	14-51	12±4	30±6
6	2D-135(2)	22.0±12.7	10-40	11±8	20±7
7	2D-143(10)	21.8±6.5	14-29	4±2	36±11
8	2D-145(13)	20.2±10.5	10-37	29±26	28±14
9	2D-141(5)	19.8±12.4	13-42	36±21	26±11
10	2D-138(7)	18.0±10.9	5-38	23±32	29±11
11	2D-137(4)	18.0±6.3	13-28	8±8	31±11
12	2D-136(3)	13.4±9.9	8-31	3±2	27±7
13	2D-139(3)	12.0±1.4	11-13	90±4	4±3
14	2D-146(14)	11.0±1.0	10-12	68±19	13±8

The greatest variability in lead concentration levels is found in 2D-140(9) in the eastern channel margins near Point Richmond. This variability is represented by standard deviation in lead levels of 15.1

ppm. Hole 2D-140(9) has a mean hole sand and clay content of 12 ± 4 and 30 ± 6 percent. The sediment in this hole is clayey silt uniformly distributed with depth. The clay content decreases from 37 percent in surface sediments to 29 percent at the bottom of the hole. Lead concentrations 51 ppm at the surface to 14 ppm at depth. Hole 2D-142(12) experiences a similar distribution pattern. The large deviation from the mean lead concentration in these two holes is due to very high lead concentration in surface sediments decreasing to much lower levels with depth.

Hole 2D-138(7) located in Berkeley Flats has a vertical gradient in lead concentration varying from 38 ppm in the surface sediments to 5 ppm at about 20 feet below Bay bottom. The latter value is the lowest lead concentration found in all sediment samples from San Pablo Strait-Berkeley Flats. This variation reflects the radical differences in lead levels found in New and Old Bay Mud. New Bay Mud in this part of the Bay extends to a depth of approximately 15 feet below Bay bottom. Lead levels in the New Bay Mud deposits of 2D-138(7) vary from 38 to 19 ppm with a sand content of less than 10 percent. The Old Bay Mud represented by the deepest sample in this hole has a sand content of 85 percent.

The lowest mean hole lead concentrations are found in holes 2D-139(8) located in Southampton Shoal and 2D-146(14) in West Richmond Channel. Sediments in these holes represent the coarsest sediments in the San Pablo Strait-Berkeley Flats area and are primarily fine sand. Lead concentrations in the holes show little deviation with depth. Mean hole lead levels for 2D-146(14) and 2D-139(8) are 11.0 ± 1.0 and 12.0 ± 1.4 ppm. In 2D-146(14) the percent sand decreases slightly with depth. The sediment in 2D-139(8) at Southampton Shoal is densely compacted, fine sand. Hole 2D-136(3) located in Berkeley Flats has an extremely low in mean hole lead concentration (13.4 ± 9.9 ppm) when compared to the low sand content of the hole. Sediment in this hole is a fairly uniformly distributed clayey silt. Except for a lead value of 31 ppm in the surface sediment, lead levels are low and are uniformly distributed with depth.

Zinc. The mean zinc concentration in San Pablo Strait-Berkeley Flats sediments is 110 ± 40 ppm, which is slightly lower than the mean zinc level in the San Pablo Bay-Carquinez Strait area. Mean hole zinc concentrations associated with bottom sediments in San Pablo Strait-Berkeley Flats range from 188 ± 17.5 ppm in the western channel margins to 65 ± 21.8 ppm in the deep water channel of Central Bay. Table 27 lists the mean hole lead concentrations in order of decreasing magnitude.

The highest mean hole zinc concentrations in San Pablo Strait-Berkeley Flats are found at 2D-147(6), and 2D-142(12), both along the western channel margins. Sediments in these two holes are predominantly a clayey silt uniformly distributed with depth. Zinc levels in 2D-147(6) decreases from 206 ppm in the surface sediments to 172 ppm at about 15 feet below the Bay bottom. Vertical distribution of zinc in 2D-142(12) follows a similar pattern with highest concentrations in the surface sediments decreasing with depth.

TABLE 27

SAN PABLO STRAIT-BERKELEY FLATS
MEAN HOLE ZINC CONCENTRATIONS

Rating	Hole	Mean ppm	Range ppm	% Sand > 74 μ	% Clay <2 μ
1	2D-147(6)	188.7±17.5	172-206	2±1	49±5
2	2D-142(12)	183.3±25.5	152-205	4±3	42±7
3	2D-148(1)	144.2±53.3	103-204	5±6	39±9
4	2D-144(11)	132.4±22.0	98-150	3±2	39±6
5	2D-143(10)	124.4±40.7	75-175	4±2	36±7
6	2D-140(9)	122.0±37.2	98-188	12±4	30±6
7	2D-141(5)	104.4±46.6	52-179	36±21	26±11
8	2D-145(13)	99.5±34.7	57-148	29±26	28±14
9	2D-137(4)	91.6±22.1	66-116	8±8	31±11
10	2D-136(3)	85.4±16.6	72-113	3±2	27±7
11	2D-138(7)	85.8±35.5	33-123	23±32	29±11
12	2D-139(8)	77.0	77-77	90±4	4±3
13	2D-135(2)	66.0±23.3	42-51	11±8	20±7
14	2D-146(14)	65.0±21.8	43-90	68±19	13±8

The highest deviation from the mean hole zinc concentration is found in 2D-148(1) located in the San Rafael Flats and 2D-141(5) in the channel margins near the entrance to Richmond Harbor. Mean hole zinc concentration in 2D-148(1) is 144.2±53.3 ppm with a value of 201 ppm in the surface sediment decreasing to 107 ppm with depth. Sediment in this hole is a silty clay surface material and clayey silt material at depth. The mean hole zinc concentration in 2D-141(5) is 104.4±46.6 ppm. Zinc decreases from 179 ppm in the surface sediment to 52 ppm at depth. Sediment in 2D-141(5) is composed of clayey silt on the surface grading into a clayey and silty sand at depth. Zinc concentrations fluctuate widely.

Hole 2D-138(7) located on Berkeley Flats penetrates the uppermost layer of Old Bay Mud. Zinc concentrations range from 148 ppm in the New

Bay Mud to 33 ppm in the Old Bay Mud. The zinc concentration in the Old Bay Mud is the lowest zinc level found in all sediment samples taken from San Pablo Strait-Berkeley Flats.

The lowest mean hole zinc concentrations are found in holes 2D-139(8) in Southampton Shoal, 2D-135(2) in Berkeley Flats, and 2D-146(14) in West Richmond Channel. Mean hole zinc concentrations are 77.0 ppm in 2D-139(8), 66.0 $\pm$23.3 ppm in 2D-135(2) and 65.0 $\pm$21.8 ppm in 2D-146(14). Holes 2D-139(8) and 2D-146(14) have the coarsest sediments in the San Pablo Strait-Berkeley Flats area with mean hole sand contents of 90 and 68 percent, respectively. Sediments of 2D-135(2) are mainly clayey silt with clay content increasing with depth.

Cadmium. The mean cadmium concentration in San Pablo Strait-Berkeley Flats sediments is 0.95 $\pm$0.39 which is higher than the mean cadmium concentration in San Pablo Bay-Carquinez Strait. The mean hole cadmium concentrations in the sediments range from 1.58 ppm in the channel margins near the entrance to Richmond Harbor to 0.64 ppm in Berkeley Flats. Table 28 shows the mean hole cadmium concentrations in order of decreasing magnitude.

The highest mean hole cadmium concentrations in San Pablo Strait-Berkeley Flats area are found at 2D-140(9) with a mean concentration of 1.58 $\pm$0.42 ppm and 2D-141(5) with a mean concentration of 1.36 $\pm$0.24 ppm. These holes are both located just west of the entrance channel to Richmond Harbor. Sediments in 2D-140(9) are entirely clayey silt with the clay content decreasing with depth. Cadmium levels vary from 2.2 ppm in the surface sediment to 1.2 ppm at depth. 2D-141(5) has the second highest mean hole cadmium concentration. Bottom sediments of 2D-141(5) are more hetrogeneous than sediments of 2D-140(9) and range from a clayey silt at the surface (43 percent clay) to a silty sand (52 percent sand) at about 6 feet below bay bottom. Cadmium levels vary from 1.5 ppm at the surface to 1.2 ppm in the sand layer. Below the sand layer, sediment grades into clayey silt (27 percent clay) at 15 feet with a cadmium concentration of 1.3 ppm. Below 15 feet the sediments are again a silty sand layer (64 percent sand) with a cadmium level of 1.7 ppm.

TABLE 28

SAN PABLO STRAIT-BERKELEY FLATS
MEAN HOLE CADMIUM CONCENTRATIONS

Rating	Hole	Mean ppm	Range ppm	% Sand > 74 μ	% Clay <2 μ
1	2D-140(9)	1.58 ±0.42	1.0-2.2	12 ±4	30 ±6
2	2D-141(5)	1.36 ±0.24	1.1-1.5	36 ±21	26 ±11
3	2D-147(6)	1.27 ±0.12	1.2-1.4	2 ±1	49 ±5
4	2D-148(1)	1.20 ±0.46	0.7-1.9	5 ±6	39 ±9
5	2D-142(12)	1.13 ±0.32	0.9-1.6	4 ±3	42 ±7
6	2D-143(10)	0.92 ±0.13	0.7-1.0	4 ±2	36 ±7
7	2D-144(11)	0.86 ±0.09	0.8-1.0	3 ±2	39 ±6
8	2D-138(7)	0.83 ±0.48	0.5-1.8	23 ±32	29 ±11
9	2D-145(13)	0.72 ±0.12	0.6-0.9	29 ±26	28 ±14
10	2D-137(4)	0.70 ±0.20	0.4-0.9	8 ±8	31 ±11
11	2D-146(14)	0.70 ±0.16	0.5-0.8	68 ±19	13 ±8
12	2D-139(8)	0.70 ±0.14	0.6-0.8	90 ±4	4 ±3
13	2D-135(2)	0.65 ±0.06	0.6-0.7	11 ±8	20 ±7
14	2D-136(3)	0.64 ±0.05	0.6-0.7	3 ±2	27 ±7

The greatest variability in mean hole cadmium is found in 2D-138(7), located in Berkeley Flats and 2D-148(1) located in the western shallow subtidal flats near San Rafael Flats. Mean hole cadmium concentration in 2D-138(7) is 0.83 ±0.48 ppm varying from 0.7 ppm in the surface sediment to 1.8 at about 15 feet below Bay bottom. The upper 15 feet of 2D-138(7) is a clayey silt material of New Bay Mud. Sediment in the bottom of this hole at about 20 feet is silty sand (85 percent sand) with a cadmium level of 0.5 ppm. This cadmium value equals the lowest cadmium concentration found in San Pablo Strait-Berkeley Flats sediments. This sample is from the upper level of the Old Bay Mud formation. 2D-148(1) has a mean hole cadmium concentration of 1.20 ±0.46 ppm. Sediments in this hole range from silty clay (51 percent clay) in surface sediment to clayey silt (37 percent clay) at depth. High deviation in the mean hole cadmium concentration of 2D-148(8) is a result of high cadmium values in the upper 10 feet. Cadmium levels range from 1.2 ppm in surface sediment to 1.9 ppm at about 10 feet. The deepest samples of 2D-148(8) have cadmium levels of 0.9 ppm and 0.7 ppm, respectively.

Lowest mean hole cadmium concentrations are found at 2D-135(2) and 2D-136(3) in Berkeley Flats. Mean hole cadmium values of these holes

are 0.65 ±0.06 ppm and 0.64 ±0.05 ppm, respectively. Sediments in these two holes are primarily clayey silt. Hole 2D-136(3) has one of the lowest sand contents in San Pablo Strait-Berkeley Flats area. Cadmium levels range from 0.7 ppm in surface sediment of 2D-136(3) to 0.6 ppm at depth of about 24 feet.

Copper. The mean copper concentration in San Pablo Strait-Berkeley Flats area is 39.7 ±14.5 ppm which is six ppm higher than the mean copper concentration in bottom sediments in San Pablo Bay-Carquinez Strait area. Mean hole copper concentrations range from 63 ±5.5 ppm in the western channel margins to 15 ±2 ppm in Southampton Shoal. Table 29 lists mean hole copper concentrations in order of decreasing magnitude.

The highest mean hole copper concentrations in San Pablo Strait-Berkeley Flats are found at 2D-147(6) with a mean of 63.3 ±5.5 ppm and 2D-142(12) with a mean of 61.5 ±19.6 ppm. Both these holes are located in the western channel margins. Sediments in these holes are classified as silty clay and clayey silt and contain over 95 percent clays and silts. Distribution of these sediments is quite homogeneous with depth. Copper levels in 2D-147(6) decrease from 67 ppm in surface sediment to 57 ppm at 15 feet below the Bay bottom.

The greatest variablity in mean hole copper concentrations are found in hole 2D-141(5) located in the eastern channel margins near Richmond and hole 2D-142(12) in the western channel margins. Sediment in 2D-141(5) is heterogeneous sediment layers with sand and silt fractions increasing with depth. Mean hole sand and clay content is 36 ±21 percent and 26 ±11 percent. Surface sediment is clayey silt with a copper concentration of 70 ppm. Between 4.4 and 5.7 feet below the Bay bottom, sediment is sandy silt and clayey sand with copper levels at 23 ppm. At about 15 feet below Bay bottom there is a layer of clayey silt with copper concentration increasing to 31 ppm. Below this depth the sediment is silty sand with a copper concentration of 12 ppm. 2D-142(12) has the second greatest variation in copper concentration and also ranks second highest in mean hole copper level. Sediment throughout the depth of this hole is clayey silt with a mean hole content of over 95 percent silts and clays.

TABLE 29

SAN PABLO STRAIT-BERKELEY FLATS
MEAN HOLE COPPER CONCENTRATIONS

Rating	Hole	Mean ppm	Range ppm	% Sand > 74 μ	% Clay <2 μ
1	2D-147(6)	63.3 ±5.5	57-67	2 ±1	49 ±5
2	2D-142(12)	61.5 ±19.5	44-89	4 ±3	42 ±7
3	2D-148(1)	50.8 ±14.9	38-66	5 ±6	39 ±9
4	2D-143(10)	47.6 ±11.3	35-59	4 ±2	36 ±7
5	2D-137(4)	45.2 ±12.1	32-59	8 ±8	31 ±11
6	2D-144(11)	43.4 ±8.6	31-53	3 ±2	39 ±6
7	2D-140(9)	42.2 ±16.0	25-67	12 ±4	30 ±6
8	2D-136(3)	42.2 ±10.4	31-55	3 ±2	27 ±7
9	2D-138(7)	39.1 ±15.2	13-60	23 ±32	29 ±11
10	2D-141(5)	31.8 ±22.4	12-70	36 ±21	26 ±11
11	2D-145(13)	28.5 ±16.7	12-49	29 ±26	28 ±14
12	2D-135(2)	26.7 ±14.6	14-46	11 ±8	20 ±7
13	2D-146(14)	16.6 ±11.5	7-31	68 ±19	13 ±8
14	2D-139(8)	14.5 ±2.1	13-16	90 ±4	4 ±3

The highest standard deviation in this hole is caused by a copper concentration of 89 ppm at six feet below Bay bottom. This is the highest measured value of all samples taken in San Pablo Strait-Berkeley Flats.

Lowest mean hole copper concentrations are found in hole 2D-135(2) in Berkeley Flats, 2D-146(14) in the West Richmond Channel and 2D-139(8) in Southampton Shoal. Mean hole copper concentrations are 27 ±14.6 ppm in 2D-135(2), 17 ±11.5 ppm in 2D-146(14) and 15 ±2 ppm in 2D-139(8). Sediments in these latter two holes are the coarsest found in San Pablo Strait-Berkeley Flats. Copper concentrations in 2D-146(14) range from 10 ppm in the surface sediments to 31 ppm at about 14 feet. Clay content in 2D-146(14) increases with depth from 6 percent to 25 percent at the bottom of the hole. Sand content varies inversely with depth decreasing from 87 percent in the surface sediment to 38 percent at depth.

SUMMARY

Contaminant levels in sediments of the San Pablo Strait-Berkeley Flats area vary widely both spatially and temporally; however, the variability is not nearly as widespread as in the San Pablo Bay-Carquinez Strait area. Surface sediments are enriched with all nine contaminants. There is a definite relationship between contaminant levels and sediment type (particle size) which is reflected in both the vertical and horizontal distribution of contaminants. Contaminant levels associated with the fine sediments are generally lower than the levels found in San Pablo Bay-Carquinez Strait.

The surface sediments of the western shallow subtidal flats and western channel margins of Central Bay have the highest levels of most of the nine contaminants. These sediments are the finest in the San Pablo Strait-Berkeley Flats area and are very similar in physical characteristics to the clayey silts of the northern shallows of San Pablo Bay and Mare Island Strait. The surface sediments of the eastern channel margins also have high contaminant levels. Contaminant levels in the surface sediments of Berkeley Flats are generally lower than in other shallow water areas of the Bay primarily because of the high silt content of the surface sediments. The lowest contaminant levels in surface sediments of this area are found in deep water of West Richmond Channel and Southampton Shoal. The sediments found in these areas are also the coarsest material in Central Bay.

The vertical distribution of contaminants in San Pablo Strait-Berkeley Flats area follows the same general trend as in San Pablo Bay-Carquinez Strait. Contaminant levels on the whole are lower and the spatial and temporal variability of contaminants is less than in San Pablo Bay-Carquinez Strait area. The relationship between contaminant levels and sediment type (particle size) is better developed in the San Pablo Strait-Berkeley Flats area.

The San Pablo Strait-Berkeley Flats area is categorized into four sub-areas according to the geographical location, distribution of contaminants in the sediments, and the physical characteristics of the area. These sub-areas include; western subtidal flats and channel margins; channel margins near Richmond; Berkeley Flats; and deepwater channels and Southampton Shoal.

Western Subtidal Flats and Channel Margins

The area encompasses the subtidal flats and channel margins of Corte Madera and San Rafael. Four holes are located in this sub-area:

2D-148(1) and 2D-144(11) in the shallow subtidal flats and 2D-147(6) and 2D-142(12) along the western channel margins. This area is characterized as uniformly low energy environment. Wind-wave action is normally low because of the protection provided by the Marin shoreline from prevailing westerlies. The current velocities are small because the area is out of the major water circulation pattern of Central Bay. Historically this area has experienced among the highest shoaling rates in San Francisco Bay (Figure 33). The sediments of the area are exclusively clayey silts, uniformly distributed with depth. These sediments are very similar to the clayey silts in the northern shallows of San Pablo Bay. Seismic reflection profile records in the western subtidal flats and upper channel margins show it to be an area of limited penetration.

This area has the highest contaminant levels in the San Pablo Strait-Berkeley Flats area. Typical distributions of contaminants in the western subtidal flats and channel margins are generally uniform or decrease with depth. Cadmium levels in 2D-142(12) and 2D-144(11) are substantially lower than other holes in this sub-area. Total Kjeldahl nitrogen concentrations in the deeper sediments of 2D-142(12) are extremely low. Mercury and COD levels in 2D-148(1) are lower than the other holes in this sub-area.

Overall this sub-area has the highest contaminant levels in the San Pablo Strait-Berkeley Flats area; however, the contaminants are consistently lower in this area than in comparable areas and sediments of San Pablo Bay-Carquinez Strait area.

Channel Margins near Richmond

The area is located on the east side of Central Bay near Richmond Harbor in water depths between 10 and 30 feet. Three holes are located in this sub-area; 2D-143(10) on the east side of the entrance channel to Richmond Harbor and 2D-140(9) and 2D-141(5) on the west side of the entrance channel. The sediments of this area are somewhat coarser and more hetrogeneous with depth than on the western side of Central Bay. Going from the upper channel margins to the deeper channel margins, the sediments become coarser and more hetrogeneous with depth. The sediment of 2D-143(10) in the upper channel margins (-19 feet MLLW) of this area is a uniformly distributed clayey silt. The sediment of 2D-140(9) in the lower channel margins is also a clayey silt, but the sand content is greater. The sediment of 2D-141(5) located further offshore in the lower channel margins varies with depth from clayey-silt to sandy silt and silty sand. Like in the eastern channel margins, this area has historically experienced the highest shoaling rates in the Bay.

The sediments of this area have lower contaminant levels as a whole than the western channel margins of Central Bay. Cadmium levels, however, are somewhat higher than on the western side of Central Bay. The vertical distribution of contaminants in the upper channel margins is fairly uniform. The distribution in the sediments of the lower channel margins is, for most of the contaminants, much more variable.

The entrance channel to Richmond Harbor is located in this area and the sediments have similar contaminant levels as in 2D-143(10) in the upper channel margins.

Berkeley Flats

This area is located in the extensive shallow subtidal flats of the eastern side of Central Bay. Four holes are located in this area; 2D-138(7), 2D-137(4), 2D-136(3), and 2D-135(2). This area is characterized by a high wave and low current energy environment. The sediments differ substantially from those of the western shallow subtidal flats in that the clay content is less, the silt content greater, and the sand content is about the same. Historically much of the area has experienced very little shoaling or even slight erosion (Figure 33). Berkeley Flats area is exposed to steep, short period waves generated by summer winds. Although this area is out of the major water circulation pattern of Central Bay, current velocities are generally greater than along the western subtidal flats and are sufficient to transport sediments suspended by wave action out of the area.

Contaminant levels in this area are low despite the relatively fine sediments. Contaminants are generally distributed uniformly with depth and the surface sediments are slightly enriched with most of the nine contaminants. Contaminant levels in the Old Bay Mud deposits are at depths greater than 15 feet below Bay bottom. One sample in this deposit has high concentrations of cadmium (1.8 ppm), zinc (127 ppm), and volatile solids ($7x10^4$ ppm).

Deep Water Channels and Southampton Shoal

This area is located at water depths greater than 30 feet in West Richmond Channel and along Southampton Shoal. Three holes are included; 2D-139(8), 2D-145(13) and 2D-146(14). The area is characterized as a high current energy environment where the sediments are predominantly silty sand. The upper five feet of sediment of 2D-145(13), however, is a clayey silt.

Contaminant levels are the lowest in San Pablo Strait-Berkeley Flats and the sediments are the coarsest.

OAKLAND INNER-OUTER HARBOR

DESCRIPTION

Oakland Inner-Outer Harbor area shown on Figure 39 forms two components of the Port of Oakland complex. This rapidly developing port is the largest general cargo facility in San Francisco Bay and the leading containership terminal on the Pacific coast. The majority of the waterfront property of this area has been developed for industrial use and much of the bottom surface area is maintained navigation channels to service shoreside facilities.

Oakland Inner Harbor is a long narrow estuary about six miles in length, connecting San Francisco Bay to San Leandro Bay. The Inner Harbor navigation channel is maintained to a depth of 35 feet MLLW and width of 800 feet between the mouth of Oakland Estuary to just east of Government Island. The Oakland Tidal Canal on the eastern end of the estuary is an authorized Federal channel, but has not been maintained for a number of years. Water depths varies between 10 feet and 20 feet below MLLW in the Tidal Canal. Where berthing areas are not maintained, the shoulders of the navigation channel are quite shallow, varying in depth from five to fifteen feet below MLLW.

Oakland Outer Harbor is much more exposed than the Inner Harbor. The Federally maintained navigation channel is 35 feet deep and between 600 and 950 feet wide. The navigation channel cuts through periphery shallows that are from 10 feet to 25 feet deep. Most of the Oakland waterfront is the results of extensive land reclamation and dredging operations.

Shallow water areas exist along the periphery of the Oakland area. On the north these shallow areas are an extension of Berkeley Flats and range in depth from five to 15 feet. On the south, opposite Alameda, the shallow areas are from 15 feet to 25 feet deep. In the past these shallow areas were much more extensive, but over the last century much of the shallow intertidal and subtidal flats have been filled to extend the shoreline towards deeper water.

<u>Tide and Tidal Currents</u>

Oakland Inner - Outer Harbor are low current energy areas. Because of the enclosed nature of the Inner Harbor and isolated nature of the

OAKLAND INNER OUTER HARBOR AREA

FIGURE 39

Outer Harbor, current velocities rarely exceed 0.5 knots. The tidal currents in the Inner Harbor are generally bidirectional due to the length and narrowness of Oakland Estuary. Large, low-velocity current eddies are formed in the Outer Harbor because of projections such as the Bay Bridge toll plaza and Seventh Street Terminal. In the shallow periphery areas, both the flood and ebb surface currents flow parallel to the east shore of the Bay.

Water Circulation and Mixing Characteristics

The Oakland Inner-Outer Harbor area is situated in a boundary zone separating South Bay from Central Bay and is exposed to the circulation patterns peculiar to each. Generalized surface flow patterns during typical flood and ebb tidal conditions in this area are shown on Figure 40. Flood currents transport well mixed waters from Central Bay into South Bay via the pass between Yerba Buena Island and the Oakland waterfront. These southeast setting currents generally move parallel to the eastern shore and then turn and flow in an easterly direction into the Oakland Inner and Outer Harbor navigation channels. Ebb currents move north through the same pass, drawing water out of the Oakland Estuary and Oakland Outer Harbor. The main component of the ebb flow carrying South Bay waters into Central Bay, however, is funneled through the gap between Yerba Buena Island and San Francisco.

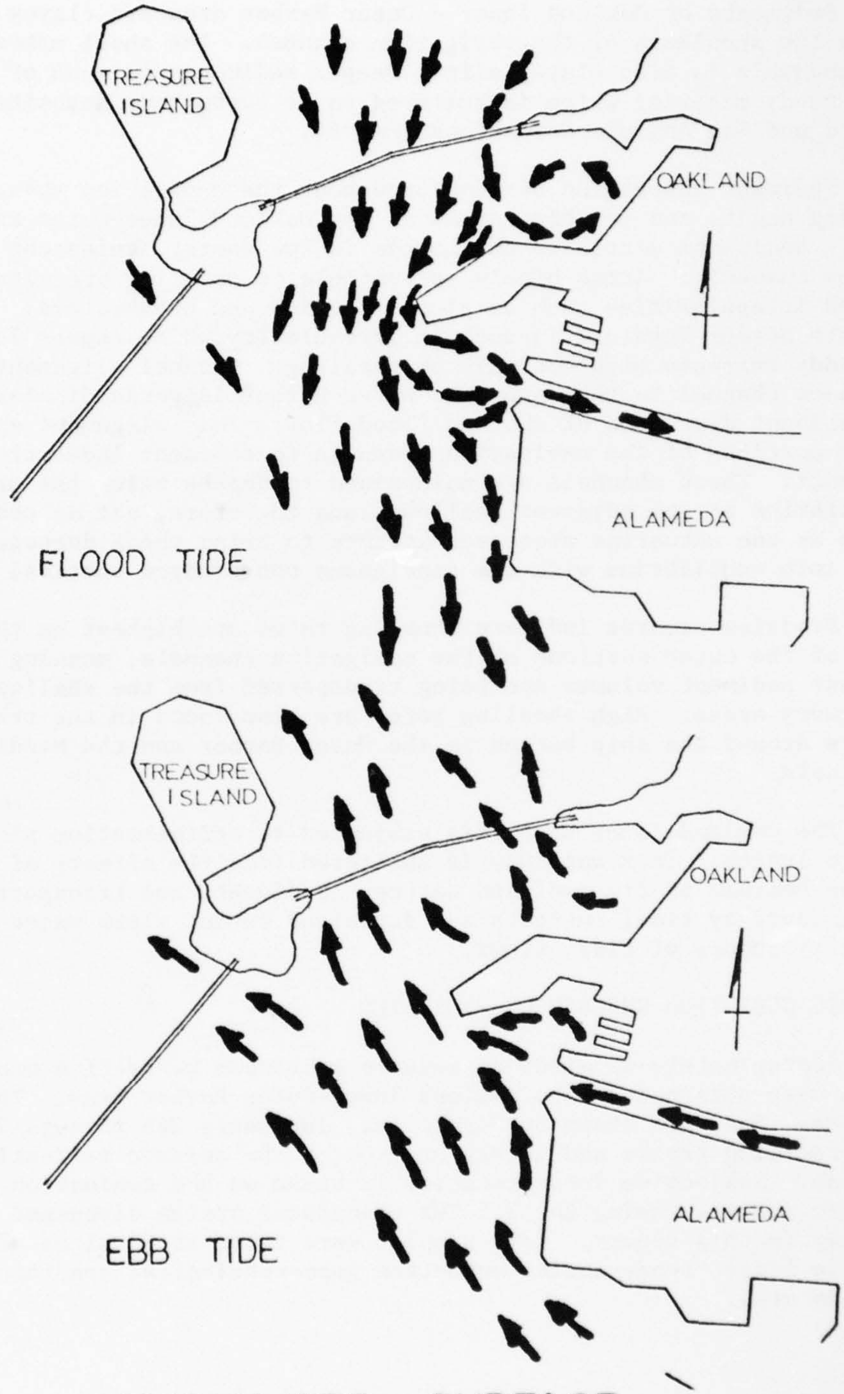
Flood predominance characterizes current circulation in the Oakland Inner-Outer Harbor area and is greatest in the bottom waters, resulting in tidal prism filling of both the Inner and Outer Harbors through the bottom water and emptying in the surface water. Normally, the bottom waters are heavily laden with suspended sediments which are brought into the navigation channels and deposited in these tranquil waters.

Wind and Wave Action

Wind-wave action plays a very minor role in resuspension of sediments in this area. However, sediments being deposited in the Outer and Inner Harbor navigation channels are derived in large part from sediments being resuspended elsewhere in the Bay system.

Sediments and Depositional Characteristics

Sediments of the Oakland Inner-Outer Harbor area are similar to those found elsewhere in San Francisco Bay. The sediments of the shallow periphery areas around Oakland are very similar to the sediments of Berkeley Flats. These sediments are a clayey silt and silt-sand-clay mixture.



GENERALIZED SURFACE
FLOW PATTERNS

FIGURE 40

Sediments of Oakland Inner - Outer Harbor area are clayey silt along the shoulders of the navigation channel. The shoal material in the channels is also clayey silt. Deeper sediments in much of the area is a sandy material which is believed to be repository deposits of the Merced and San Antonio Formations (Ref 6).

Sediment deposition occurs throughout the navigation channels, turning basins and berthing areas of the Oakland Inner-Outer Harbor area. Sediments settle to the bottom in low energy, quiescent portions of the channels. Areas highly susceptible to shoaling are situated around irregularities such as piers, jetties and breakwaters. The Seventh Street Terminal is such an irregularity which causes low velocity eddy currents with concomitant shoaling. Channel alignment of the entrance channel to the Inner and Outer Harbor is perpendicular to the predominant direction of ebb and flood flow. This alignment exposes the outer portions of the navigation channels to sediment laden cross currents. These channels are maintained to depths below the profile of equilibrium of the adjacent shallows, and therefore, act as sediment traps as the estuarine processes attempt to bring these deepened areas back into equilibrium with the contiguous non-dredged subtidal flats.

Dredging records indicate shoaling rates are highest on the north side of the outer portions of the navigation channels, meaning that the largest sediment volumes are being transported from the shallow northern periphery areas. High shoaling rates are also found in the tranquil waters around the ship berths in the Outer Harbor and the Middle Harbor terminals.

The Oakland Inner Harbor is subjected to sedimentation along its entire length. This waterway is sheltered from the effects of wind-wave action because of its enclosed nature. Sediments are transported into the estuary by tidal currents and deposited during slack water and low velocity phases of tidal flows.

SEISMIC SUBBOTTOM REFLECTION PROFILING

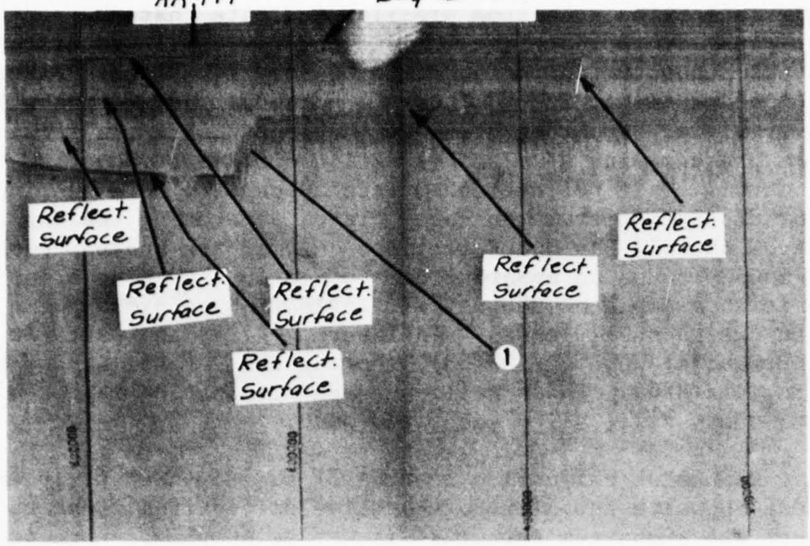
Approximately 40 miles of seismic subbottom reflection profiling lines were obtained in the Oakland Inner-Outer Harbor area. The tracks of these lines are shown on Figure 18. Inclosure 266 through 278 are the profiling tracks and interpretation of the seismic reflection records. Subjective interpretation is based on the evaluation of seismic profiles using the 3.5 KHz transducer system discussed previously in this report. Core samples were taken at 13 sites along the profile lines, representing subbottom geomorphological conditions found in this area.

Seismic reflection subbottom profiles indicate that the northern shallow periphery areas along the Oakland and Emeryville waterfront are similar to the subbottom characteristics of Berkeley Flats. Figure 41a is a section of profiling record from the northern periphery shallows opposite Emeryville. Numerous distinguishable subbottom reflection surfaces are present with a major reflection surface at about 30 feet below Bay bottom. This reflection surface appears to be a continuation of the major discontinuity in Berkeley Flats, separating the New Bay Mud Formation from the Old Bay Mud Formation. Nearer the shoreline shell lenses and mounds cause an apparent disruption in this discontinuity. Figure 41b is an example of the seismic reflection record showing the interruption due to shell lenses. Inclosure 4-47 is the particle size gradation curves for Hole 2D-105(38), showing the variability of the sediments in this area. These sediments are alternating layers of clayey silt, sandy silt, silty sand, and sand.

Seismic subbottom reflection records of the southern periphery shallow areas opposite the Alameda shoreline differ from those to the north in that the subbottom structure is not as complex. A major subbottom feature is located at about 15 feet below Bay bottom, but does not appear to represent a major discontinuity such as is found in the northern periphery shallow areas. Figure 42 is an example of the profiling track in this area. The particle size gradation curves of Hole 2D-100(39) in the southern periphery shallows, indicates that the sediments are more homogeneous than in the northern areas and are clayey silt and sand-silt-clay mixtures.

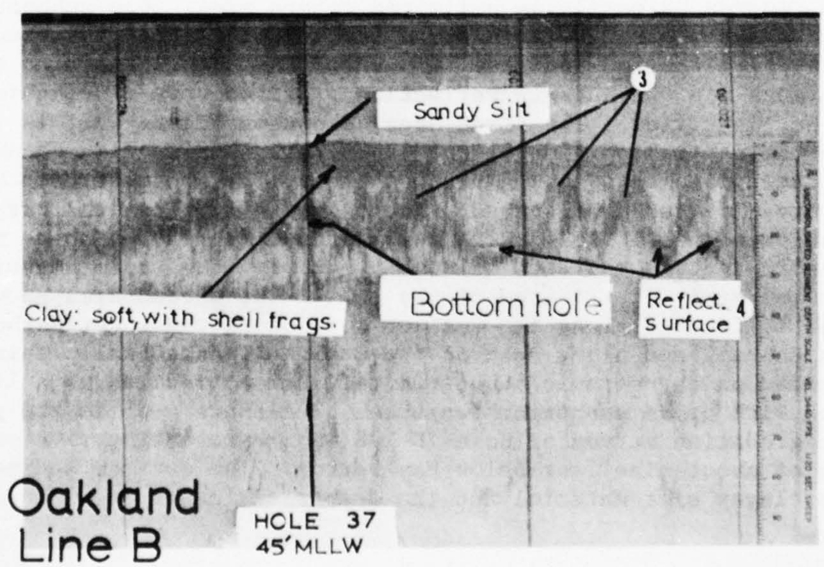
Oakland Inner Harbor is characterized on the seismic subbottom reflection records primarily as a limited return area. Few subbottom reflecting surfaces are discernible and the seismic signal is attenuated in the first five feet of sediment in much of the area. Based on the logs of borings and the seismic reflection profiles, two distinguishable areas can be identified. The first area, shown on Figure 43a, is located in the central portion of the Inner Harbor navigation channel and is characterized as a no penetration area. The sediments of this area are very fine and homogeneous. Inclosure 4-55, 56 is the particle size gradation curves of Hole 2D-95(44) representing five samples to a depth of approximately ten feet below Bay bottom. The sediments of this hole are a uniformly distributed clayey silt. The second area shown on Figure 43b, is located along the western portion of the Inner Harbor navigation channel and along much of the Oakland Tidal Canal. This area is represented on the seismic subbottom reflection profiles as a limited penetration with gross subbottom features. Inclosure 4-58 is the particle size gradation curves of Hole 2D-198(46) representing five samples to a depth of about nine feet below Bay bottom. The surface sediments are a fine clayey silt material and the deeper sediments are a sandy material.

AA 149 Bay Bottom



A. AREA OF EMERYVILLE

B 2-5

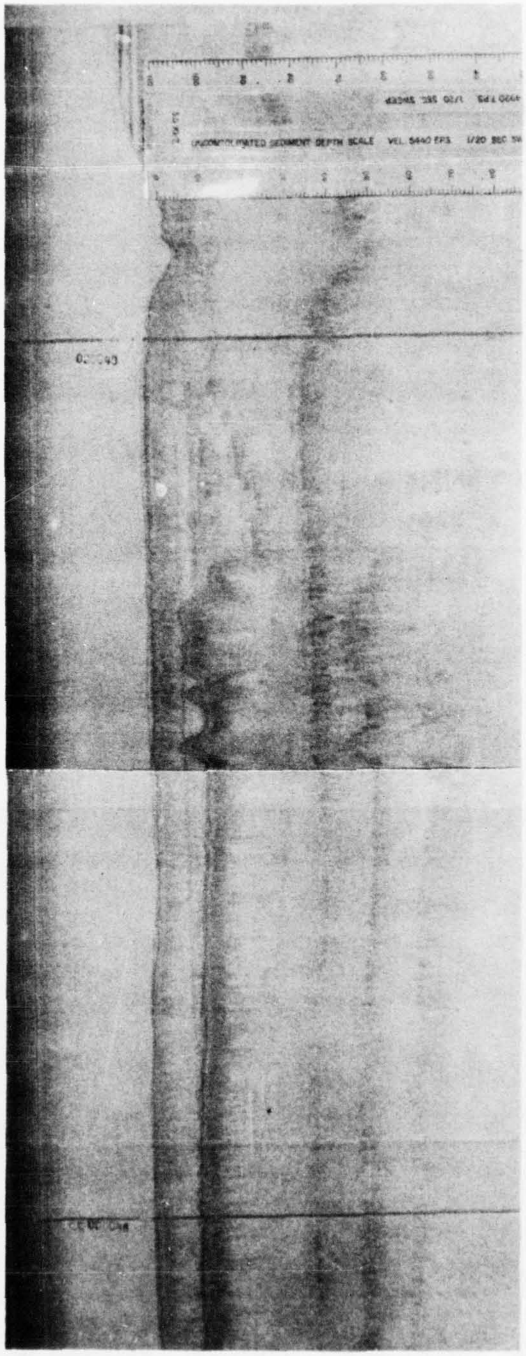


B. AREA WITH SHELL LENSES

B 24-27

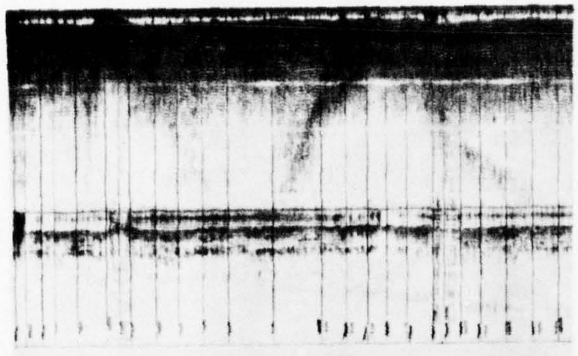
PERIPHERY AREAS NORTH OF OAKLAND HARBOR

FIGURE 41

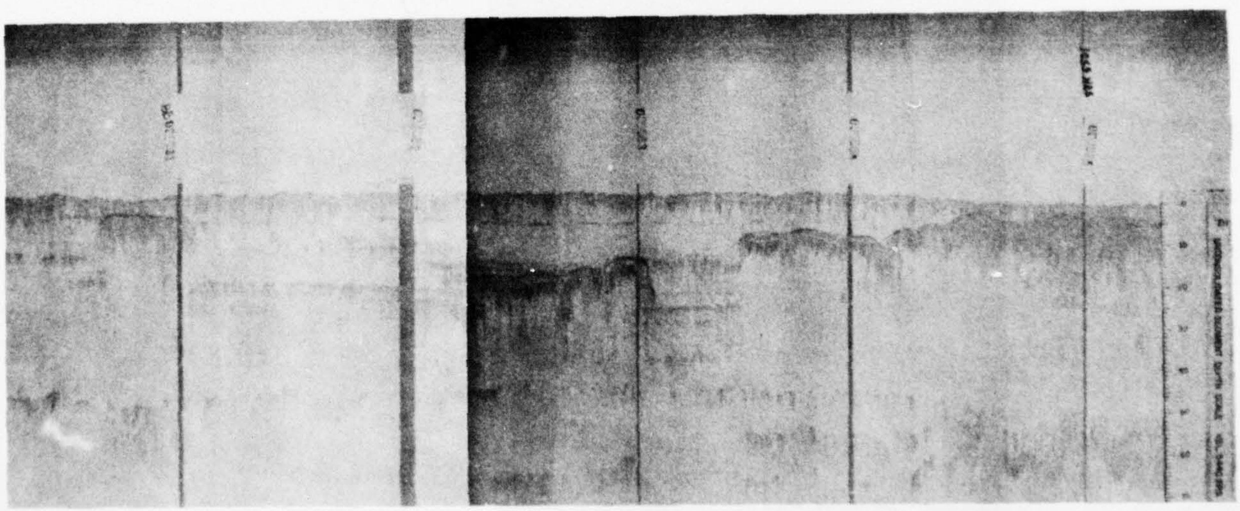


PERIPHERY AREA SOUTH OF OAKLAND HARBOR
CC 48-49

FIGURE 42



A. OAKLAND INNER HARBOR
Z 336 - 360



B. ENTRANCE TO OAKLAND INNER HARBOR
BB 80 - 85

FIGURE 43

The seismic subbottom reflection profiles of Oakland Outer Harbor are similar to Oakland Inner Harbor in that there are some areas with little or no penetration of the seismic signal and areas where gross subbottom features are discernible.

Figure 44 is a section of the Outer Harbor seismic reflection record showing a reflection surface at about three feet below Bay bottom and evidence of other reflection surfaces at deeper depths. The particle size gradation curves of 2D-107(41) located in this area, shown on Inclosure 452, indicate that the surface sediments are a clayey silt material and deeper sediments are a sandy material.

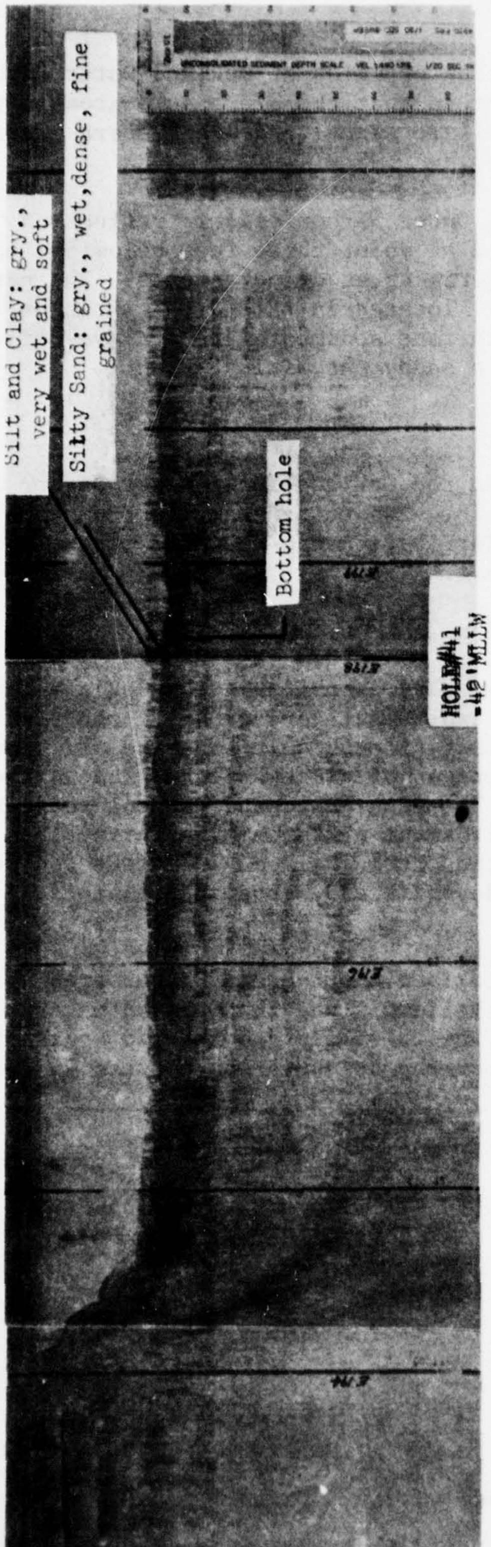
CORE SAMPLING AND ANALYSIS

Thirteen holes were drilled in the Oakland Inner-Outer Harbor area. The locations are shown on Figure 18. Two to six samples from each core were analyzed for particle size distribution and the nine contaminants. The results are shown in Inclosure 4.

Physical Sedimentary Characteristics

Size characteristics of sedimentary deposits in the Oakland-Inner-Outer Harbor area, like the other two areas, vary greatly both vertically and laterally. Table 30 is a listing of mean hole sand and clay content in order of decreasing clay percentages of core samples taken in the Oakland Inner-Outer Harbor area. The mean hole sand content indicates the relative magnitude of the environment of deposition during the history of deposition. The deviation from the mean indicates the degree of uniformity or hetrogeneity of deposits and, thus, the historical changes in input energy.

The finest sediments in the Oakland Inner-Outer Harbor area are generally found in the periphery shallows along the Oakland waterfront. The sediments are primarily clayey silt, similar to the sediments of Berkeley Flats. The clay content of the holes varies between 20 percent and 40 percent.



OAKLAND OUTER HARBOR
E 193 - 201

FIGURE 44

Holes 2D-134(36) and 2D-105(38) in Emeryville Flats are somewhat coarser and more variable sediments. The sediments of these two holes vary from a clayey silt to sandy material. The hetrogeneity of the sediments is similar to that found in the western channel margins of Central Bay.

With the exception of 2D-95(44), sediments of Oakland Inner Harbor are generally coarser than sediments along the periphery shallows. Hole 2D-99(46) is a example of typical shoaled sediments in the dredged channel. The first five feet of sediment in this hole is a clayey silt with a sand content of about two percent. Sediment deeper than five feet below Bay bottom is a silty sand and sandy material which has not been disturbed by dredging. Sediments of 2D-101(47) also in Oakland Inner Harbor are the coarsest sediments found in the Oakland Inner Outer Harbor area. Sediments of 2D94(45) in the Oakland Tidal Canal are also very coarse with the sand content varying from 38 to 88 percent.

TABLE 30

OAKLAND INNER-OUTER HARBOR
PHYSICAL SEDIMENTARY CHARACTERISTICS

Rating	Hole	Location	% Clay <2 μ	% Sand > 74 μ
1	2D-95(44)	Oakland Inner Harbor	39±4	3±2
2	2D-103(40)	Oakland Shallows	33±9	11±14
3	2D-100(39	Oakland Shallows	33±7	15±14
4	2D-106(37)	Oakland Shallows	30±6	13±14
5	2D-107(41)	Oakland Outer Harbor	28±29	43±58
6	2D-102(43)	Oakland Shallows	26±6	15±5
7	2D-99(46)	Oakland Inner Harbor	22±12	32±43
8	2D-105(38)	Emeryville Flats	20±10	39±29
9	2D-134(36)	Emeryville Flats	18±9	52±28
10	2D-98(48)	Oakland Inner Harbor	16±9	67±22
11	2D-94(45)	Oakland Tidal Canal	16±9	60±21
12	2D-104(42)	Oakland Outer Harbor	7±2	88±2
13	2D-101(47)	Oakland Inner Harbor	3±1	94±2

The two holes drilled in Oakland Outer Harbor, 2D-104(42) and 2D-107(41) are principally a sandy material. However, shoaling sediments in the Outer Harbor dredged during the annual maintenance of the navigation channel are known to be a clayey silt. The surface sample of 2D-107(41), a clayey silt, represents shoaled sediments, whereas other sediments sampled represent sediments that have not been disturbed by dredging.

In summary, the finest sediments in this area are found along the periphery shallows and the shoal sediments of Oakland Inner and Outer Harbor. The most variable sediments are found along the Emeryville Flats and the coarsest sediments are found at the deeper depths in Oakland Inner and Outer Harbor.

Distribution of Contaminants in Surface Sediments

The surface sediments of the Oakland Inner-Outer Harbor area are enriched with all of the nine contaminants. Table 31 is a comparison of the mean contaminant levels in the surface sediments (0-0.6 feet) with sediments greater than 0.6 feet.

TABLE 31

MEAN CONCENTRATION OF CONTAMINANTS IN SURFACE AND SUBSURFACE SEDIMENTS OF OAKLAND INNER-OUTER HARBOR AREA

Parameter	Mean Concentration (ppm) 0-0.6 Feet	Greater Than 0.6 Feet	% Greater Than
Lead	83.85	31.96	62
Zinc	159.08	93.60	41
Mercury	0.86	0.59	31
Cadmium	1.17	0.87	26
Copper	51.69	31.40	39
Oil-Grease	1,100	600	46
Volatile Solids $x10^4$	6.89	4.87	29
Chemical Oxygen Demand $x10^4$	3.91	2.93	25
Total Kjeldahl Nitrogen	1,300	900	31

Contaminant levels in the surface sediments show a large variation throughout the study area. Figure 45 and 46 give the contaminant concentrations in the surface sediments of each of the thirteen holes in the Oakland Inner-Outer Harbor area.

Zinc concentrations range from 35 ppm in the sandy surface sediments of holes 2D-104(42) in Oakland Outer Harbor and 2D-101(47) in Oakland Inner Harbor to 327 ppm in the sandy surface sediment of 2D-94(45) in

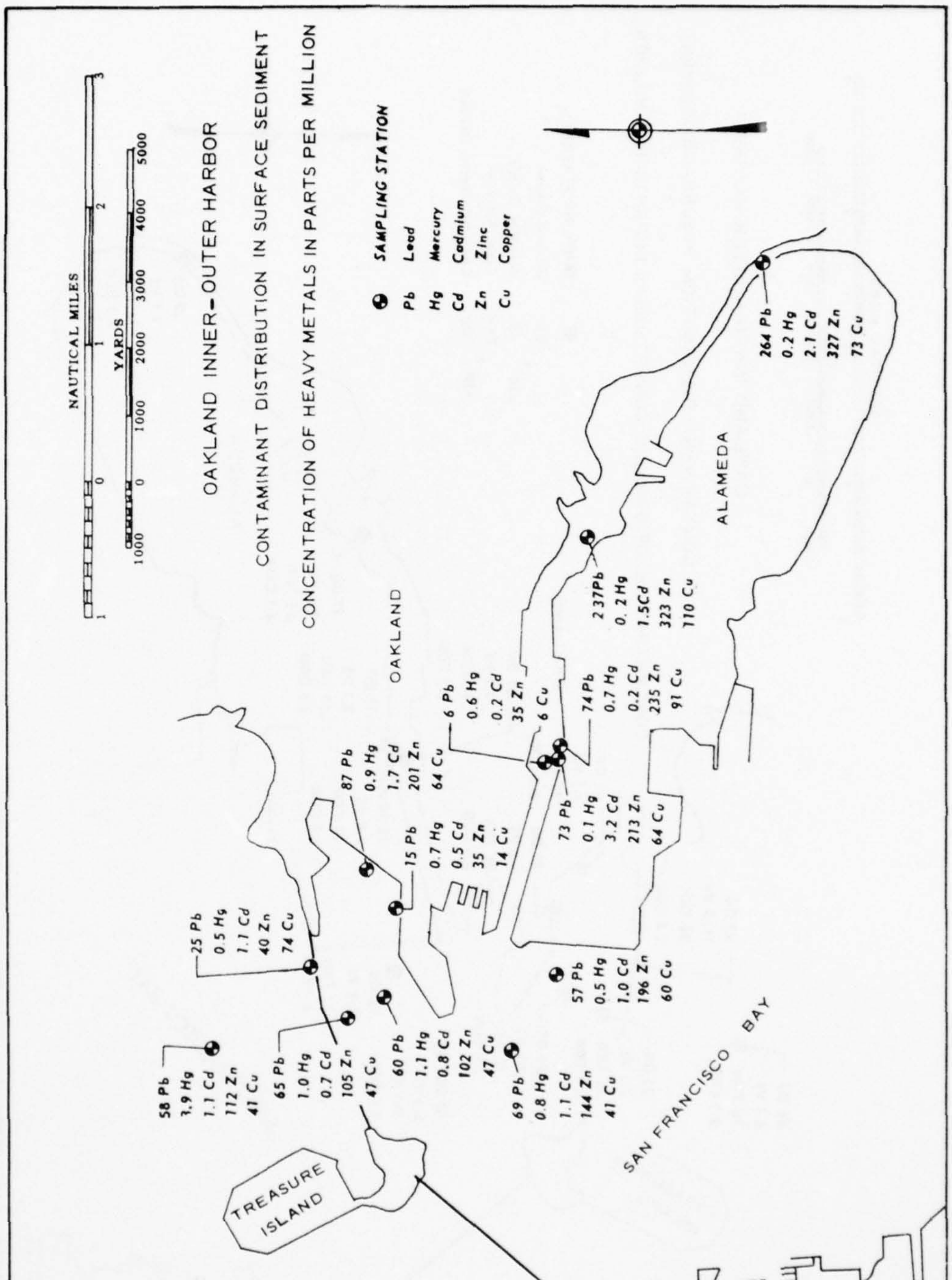

OAKLAND INNER–OUTER HARBOR
CONTAMINANT DISTRIBUTION IN SURFACE SEDIMENT
CONCENTRATION OF HEAVY METALS IN PARTS PER MILLION
NAUTICAL MILES
1 0 1 2 3
YARDS
1000 0 1000 2000 3000 4000 5000
SAMPLING STATION
Pb Lead
Hg Mercury
Cd Cadmium
Zn Zinc
Cu Copper
58 Pb
1.1 Cd
112 Zn
41 Cu
65 Pb
1.0 Hg
0.7 Cd
105 Zn
47 Cu
25 Pb
0.5 Hg
1.1 Cd
40 Zn
74 Cu
60 Pb
1.1 Hg
0.8 Cd
102 Zn
47 Cu
69 Pb
0.8 Hg
1.1 Cd
144 Zn
41 Cu
57 Pb
0.5 Hg
1.0 Cd
196 Zn
60 Cu
87 Pb
0.9 Hg
1.7 Cd
201 Zn
64 Cu
15 Pb
0.7 Hg
0.5 Cd
35 Zn
14 Cu
6 Pb
0.6 Hg
0.2 Cd
35 Zn
6 Cu
73 Pb
0.1 Hg
3.2 Cd
213 Zn
64 Cu
74 Pb
0.7 Hg
0.2 Cd
235 Zn
91 Cu
237Pb
0. 2Hg
1.5Cd
323 Zn
110 Cu
264 Pb
0.2 Hg
2.1 Cd
327 Zn
73 Cu
TREASURE ISLAND
OAKLAND
ALAMEDA
SAN FRANCISCO BAY
SAN FRANCISCO

FIGURE 45

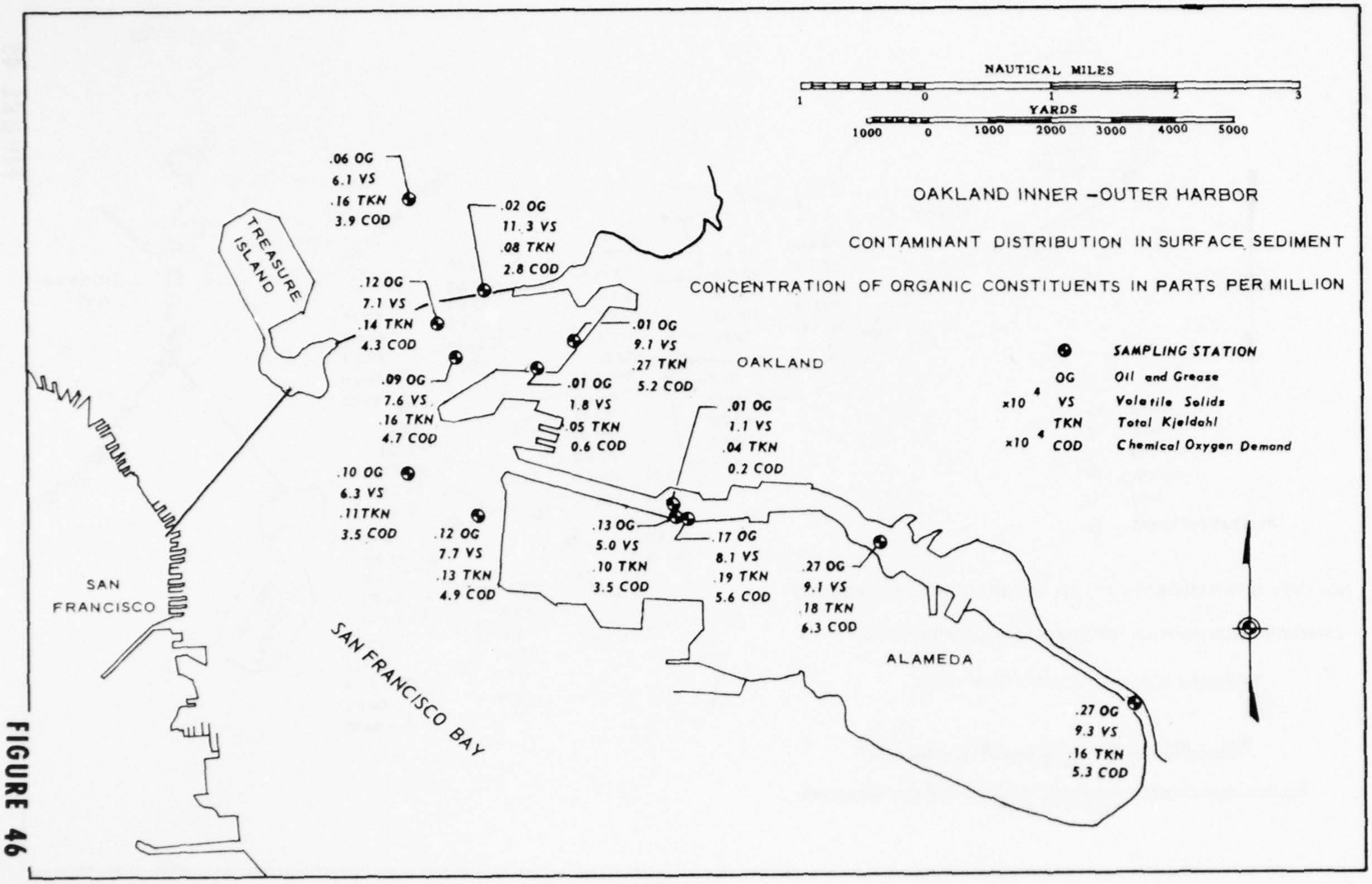

OAKLAND INNER –OUTER HARBOR
CONTAMINANT DISTRIBUTION IN SURFACE SEDIMENT
CONCENTRATION OF ORGANIC CONSTITUENTS IN PARTS PER MILLION
NAUTICAL MILES
1 0 1 2 3
YARDS
1000 0 1000 2000 3000 4000 5000
SAMPLING STATION
OG Oil and Grease
x10 4 VS Volatile Solids
TKN Total Kjeldahl
x10 4 COD Chemical Oxygen Demand
TREASURE ISLAND
SAN FRANCISCO
SAN FRANCISCO BAY
OAKLAND
ALAMEDA
.06 OG 6.1 VS .16 TKN 3.9 COD
.02 OG 11.3 VS .08 TKN 2.8 COD
.12 OG 7.1 VS .14 TKN 4.3 COD
.01 OG 9.1 VS .27 TKN 5.2 COD
.09 OG 7.6 VS .16 TKN 4.7 COD
.01 OG 1.8 VS .05 TKN 0.6 COD
.01 OG 1.1 VS .04 TKN 0.2 COD
.10 OG 6.3 VS .11 TKN 3.5 COD
.12 OG 7.7 VS .13 TKN 4.9 COD
.13 OG 5.0 VS .10 TKN 3.5 COD
.17 OG 8.1 VS .19 TKN 5.6 COD
.27 OG 9.1 VS .18 TKN 6.3 COD
.27 OG 9.3 VS .16 TKN 5.3 COD

FIGURE 46

Oakland Tidal Canal. The highest zinc concentrations in the surface sediments are found in Oakland Inner Harbor with concentrations typically exceeding 200 ppm, except for 2D-101(47). Zinc concentrations also appear to decrease going towards the entrance of Oakland Inner Harbor. The shallow periphery areas along the Oakland and Emeryville waterfront have zinc concentrations in the surface sediments ranging from 40 ppm near the Bay Bridge toll plaza to 196 ppm near Alameda Naval Air Station. The surface sediment of 2D-107(41) in Oakland Outer Harbor has a zinc concentration of 201 ppm.

Lead concentrations in the surface sediments have about the same distribution as zinc, ranging from 6 ppm at 2D-101(47) in Oakland Inner Harbor to 264 ppm in the Oakland Tidal Canal.

Mercury levels in the surface sediments range from 0.1 ppm at 2D-98(48) in Oakland Inner Harbor to 3.9 ppm at 2D-134(36) in Emeryville Flats. Oakland Inner Harbor surface sediments have mercury concentrations ranging from 0.1 ppm to 0.7 ppm. Mercury concentrations in Oakland Outer Harbor range from 0.7 ppm to 0.9 ppm. In the shallow periphery areas, mercury concentrations range from 0.5 ppm to 3.9 ppm.

Surface cadmium concentrations in the Oakland Inner-Outer Harbor 3.2 ppm at 2D-98(48) area range from to 0.2 ppm at 2D-101(47), both located in the Inner Harbor. Cadmium concentrations in the surface sediments of the Outer Harbor range from 0.5 ppm to 1.7 ppm. In the periphery shallow areas cadmium levels range from 0.7 ppm to 1.1 ppm.

Copper levels in the surface sediments range from 6 ppm to 110 ppm in Oakland Inner Harbor. In the Outer Harbor copper levels range from 14 ppm to 64 ppm, and in the periphery shallow areas the range in copper concentrations is 41 ppm to 74 ppm.

Chemical oxygen demand (COD) levels in the surface sediments of this area range from 0.2×10^4 ppm to 6.3×10^4 ppm. Both the highest and lowest concentrations are found in Oakland Inner Harbor. COD levels in the Outer Harbor range from 0.6×10^4 ppm in the sandy surface sediment of 2D-104(42) to 5.2×10^4 ppm in the clayey silt material of 2D-107(41). In the shallow periphery areas COD levels range from 2.8×10^4 ppm to 4.9×10^4 ppm.

The highest oil-grease levels in the surface sediments of this area are found in Oakland Inner Harbor. With the exception of 2D-101(47) oil-grease levels in the surface sediments of the Inner Harbor exceed 1000 ppm. The highest surface sediment oil-grease concentrations of 2700 ppm are found in 2D-94(45) and 2D-95(44). Oil-grease levels in the

surface sediments of the Outer Harbor are very low. In the periphery shallow areas oil-grease concentrations in the surface sediments range from 200 ppm to 1200 ppm.

Volatile solids levels in the surface sediments of this area range from $1.1x10^4$ ppm at 2D-101(47) in Oakland Inner Harbor to $11.3x10^4$ at 2D-105(38) in Emeryville Flats. In the Inner Harbor volatile solids levels range from $1.1x10^4$ ppm to $9.3x10^4$ ppm. Volatile solids levels in Outer Harbor range from $1.8x10^4$ ppm to $9.1x10^4$ ppm. The highest surficial volatile solids levels in this area are typically found in the periphery shallow areas where concentrations range from $6.1x10^4$ ppm to $11.3x10^4$ ppm.

Total Kjeldahl nitrogen (TKN) levels in the surface sediments of this area range from 400 ppm to 2700 ppm. In the Inner Harbor surficial TKN concentrations range from 400 ppm to 1600 ppm. In Oakland Outer Harbor TKN levels in the surface sediments range from 500 ppm to 2700 ppm, and in the periphery shallow areas TKN levels range from 800 ppm to 1600 ppm.

The surface sediments of the Oakland Inner-Outer Harbor area typically have higher contaminant levels (except for mercury) than San Pablo Bay-Carquinez Strait or San Pablo Strait-Berkeley Flats areas. In many cases high contaminant levels are found in both sandy and clayey silt surface sediments. The surface sediments of the Oakland Tidal Canal and upper portion of Oakland Inner Harbor have the highest contaminant levels, with the exception of mercury, in this area. The highest surficial mercury levels are found in the shallow periphery areas in the northern part of the Oakland Inner-Outer Harbor area. The lowest contaminant levels are found in the sandy surface sediments namely 2D-101(47) in the Inner Harbor and 2D-104(42) in the Outer Harbor.

Vertical Distribution of Contaminants

Graphs of the vertical distribution of contaminants for the Oakland Inner-Outer Harbor area are shown in Inclosure 4. Each of the contaminants are discussed in the following paragraphs in terms of mean hole concentrations and deviation from the mean.

Volatile Solids. The mean volatile solids concentrations in the Oakland Inner-Outer Harbor area is $5.31 \pm 2.8x10^4$ ppm. The mean is lower than the San Pablo Bay-Carquinez Strait and San Pablo Strait-Berkeley Flats means. The range in volatile solids concentration is somewhat greater

than in San Pablo Strait-Berkeley Flats, but smaller than in San Pablo Bay-Carquinez Strait. Volatile solids levels in the sediments of this area range from 1.1-11.5x10^4 ppm. Table 32 is a listing of the mean hole volatile solids concentrations in order of decreasing magnitude.

Mean hole volatile solids concentrations range from 1.10$\pm$0x10^4 ppm for 2D-101(47) in Oakland Inner Harbor to 7.34$\pm$1.8x10^4 ppm also in the Inner Harbor. Hole 2D-95(44) in the central portion of Oakland Inner Harbor navigation channel, near Government Island, has the highest mean hole volatile solids concentration. The sediments of this hole are clayey silt with the clay content increasing with depth. Volatile solids levels decrease with depth from 9.1x10^4 ppm at the surface to 5.3x10^4 ppm at about 6 feet below Bay bottom.

TABLE 32

OAKLAND INNER-OUTER HARBOR
MEAN HOLE VOLATILE SOLIDS CONCENTRATIONS

Rating	Hole	Mean ppm x 10^4	Range ppm x 10^4	% Sand >74 μ	% Clay <2 μ
1	2D-95(44)	7.34$\pm$1.8	5.3-9.1	3$\pm$2	39$\pm$4
2	2D-100(39	7.04$\pm$2.8	4.7-11.5	15$\pm$14	33$\pm$7
3	2D-103(40)	6.94$\pm$1.3	4.8-8.1	11$\pm$14	33$\pm$9
4	2D-106(37)	6.46$\pm$1.2	5.6-8.5	13$\pm$14	30$\pm$6
5	2D-102(43)	6.28$\pm$1.7	4.3-8.2	15$\pm$5	26$\pm$6
6	2D-99(46)	5.90$\pm$3.2	1.4-8.3	32$\pm$43	22$\pm$12
7	2D-107(41)	5.40$\pm$5.2	1.7-9.1	43$\pm$58	28$\pm$29
8	2D-94(45)	5.35$\pm$2.9	2.3-9.3	60$\pm$21	16$\pm$9
9	2D-105(38)	4.90$\pm$3.4	1.6-11.3	39$\pm$29	20$\pm$10
10	2D-134(36)	4.40$\pm$2.1	1.7-6.1	52$\pm$28	18$\pm$9
11	2D-98(48)	3.04$\pm$1.7	1.2-5.0	67$\pm$22	16$\pm$9
12	2D-104(42)	1.50$\pm$0.4	1.2-1.8	88$\pm$2	7$\pm$2
13	2D-101(47)	1.10	1.1-1.1	94$\pm$2	3$\pm$1

High mean hole volatile solids levels are also found in the shallow periphery areas south of the Bay Bridge. As exemplified by 2D-100(39) just seaward of the Alameda Naval Air Station, volatile solids levels are high throughout the depths of the holes. Volatile solids of 2D-100(39) range from 4.7-11.5x10^4 ppm. The highest sample concentration in the Oakland Inner-Outer Harbor area is found in this hole at about seven feet below Bay bottom and is associated with the coarsest sediments of the hole (35 percent sand).

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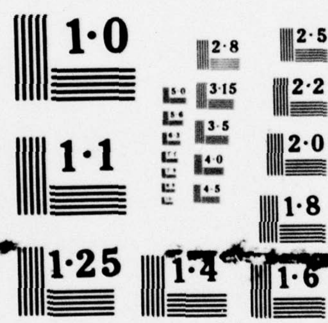

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The shoaled sediment of Oakland Inner-Outer Harbor have relatively high volatile solids concentrations, whereas the sediments undisturbed by dredging have very low volatile solids levels. Hole 2D-99(46) in the Inner Harbor and 2D-107(41) in the Outer Harbor show the differences between shoaled sediments and undisturbed sediments in these navigation channels. The high levels in the shoaled sediments result in high mean hole volatile solids concentrations.

Hole 2D-94(45) in the Oakland Tidal Canal has high volatile solids levels in the sandy surface sediments and decrease with depth, even though the clay content of the sediments increase with depth.

Mean hole volatile solids concentrations of the shallow periphery area seaward of Emeryville are lower than in the southern periphery shallows. The sediments in the northern periphery shallows are also coarser. The mean hole volatile solids concentration of 2D-105(38) is $4.90 \pm 3.4 \times 10^4$ ppm. The surface sediment of this hole has a volatile solids concentration of 11.3×10^4 ppm.

The lowest mean hole volatile solids concentrations in this area are found in the sandy sediments of the navigation channels.

Chemical Oxygen Demand. The mean chemical oxygen demand (COD) in the Oakland Inner-Outer Harbor area is lower than both the San Pablo Bay-Carquinez Strait and San Pablo Strait-Berkeley Flats areas. The COD concentrations in the sediments of this area range from 0.1×10^4 ppm to 9.0×10^4 ppm. Table 33 is a listing of mean hole COD concentrations in order of decreasing magnitude.

Mean hole COD concentrations are similar to volatile solids with the highest mean hole concentrations being found in the fine sediments of Oakland Inner Harbor and in the sediments of the shallow periphery area south of the Bay Bridge. The lowest mean hole COD concentrations are found in the undisturbed sandy sediments of the navigation channels.

Hole 2D-95(44) in the Inner Harbor has the highest mean hole COD concentration of $5.80 \pm 2.1 \times 10^4$ ppm. COD levels in this hole vary from 4.0×10^4 ppm at about seven feet below Bay bottom to 9.0×10^4 ppm at about four feet below Bay bottom. The surface sediment of this hole has a COD concentration of 6.3×10^4 ppm. The finest sediments in the Oakland Inner-Outer Harbor area are found at this hole.

TABLE 33

OAKLAND INNER-OUTER HARBOR
MEAN HOLE CHEMICAL OXYGEN DEMAND CONCENTRATIONS

Rating	Hole	Mean ppm x 10^4	Range ppm x 10^4	% Sand > 74µ	% Clay <2µ
1	2D-95(44)	5.80±2.1	3.8-9.0	3±2	39±4
2	2D-103(40)	4.34±0.8	3.1-5.1	11±14	33±9
3	2D-100(39)	4.28±0.5	3.7-4.9	15±14	33±7
4	2D_99(46)	3.78±2.6	0.1-5.7	32±43	22±12
5	2D-102(43)	3.76±0.4	3.4-4.3	15±5	26±6
6	2D-106(37)	3.76±1.0	2.2-4.8	13±14	30±6
7	2D-107(41)	2.90±3.3	0.6-5.2	43±58	28±29
8	2D-105(38)	2.61±0.9	1.5-4.1	39±29	20±10
9	2D-94(45)	2.55±2.3	0.1-5.3	60±21	16±9
10	2D-134(36)	2.48±1.5	0.3-3.9	52±28	18±9
11	2D-98(48)	1.62±1.6	0.3-3.5	67±22	16±9
12	2D-104(42)	0.06	0.6-0.6	88±2	7±2
13	2D-101(47)	0.17±0.1	0.1-0.2	94±2	3±1

The lowest mean hole COD concentrations are found in the undisturbed sandy sediments of the Inner and Outer Harbor. 2D-101(47) located in the Inner Harbor has a mean hole sand content of 94±2 percent. Correspondingly, the mean hole COD concentration is 0.17±0.1x10^4 ppm with sample concentrations ranging from 0.1-0.2x10^4 ppm.

Areas in the Inner-Outer Harbor channels where shoaled sediments are present have higher mean hole COD concentrations and larger deviations from the means. Hole 2D-99(46) located in the Inner Harbor has a mean hole COD concentration of 3.78±2.6x10^4 ppm. Sample concentrations in this hole range from 5.7x10^4 ppm in the fine surface sediments to 0.1x10^4 ppm in the deeper undisturbed sediments.

<u>Total Kjeldahl Nitrogen</u>. The mean total Kjeldahl nitrogen (TKN) concentration in the Oakland Inner-Outer Harbor area is 1,000±600 ppm. This mean is the same as San Pablo Strait-Berkeley Flats area and much less than the San Pablo Bay-Carquinez Strait mean. TKN levels in the sediments of this area range from 100 ppm to 2700 ppm. Table 34 is a listing of mean hole TKN concentrations in order of decreasing magnitude.

TABLE 34

OAKLAND INNER-OUTER HARBOR
MEAN HOLE TOTAL KJELDAHL NITROGEN CONCENTRATIONS

Rating	Hole	Mean ppm	Range ppm	% Sand > 74 μ	% Clay <2 μ
1	2D-95(44)	1700±400	1400-2300	3±2	39±4
2	2D-103(40)	1600±300	1100-1900	11±14	33±9
3	2D-107(41)	1600±1600	400-2700	43±58	28±29
4	2D-106(37)	1100	1100-1200	13±14	30±6
5	2D-99(46)	1100±900	300-1900	32±43	22±12
6	2D-102(43)	1000±200	800-1400	15±5	26±6
7	2D-100(39)	1000±300	500-1300	15±14	33±7
8	2D-134(36)	900±500	300-1600	52±28	18±9
9	2D-105(39)	800±300	500-1300	39±29	20±10
10	2D-94(45)	800±700	200-1600	60±21	16±9
11	2D-104(42)	700±200	500-800	88±2	7±2
12	2D-98(48)	500±400	200-1000	67±22	16±9
13	2D-101(47)	200±200	100-400	94±2	3±1

Like with volatile solids and chemical oxygen demand, the highest mean hole TKN concentration is found in 2D-95(44) in the fine sediments of the Inner Harbor. The mean hole concentration is 1700±400 and sample concentrations range from 2300 ppm at about five feet below Bay bottom to 1400 ppm at about six feet below Bay bottom.

The lowest mean hole TKN concentration is also found in the Inner Harbor at 2D-101(47). The mean hole concentration in these sandy sediments is 200±200 ppm.

Mean hole TKN concentrations in the shallow periphery areas range from 800±300 ppm at 2D-105(38) to 1600±300 at 2D-103(40).

Hole 2D-107(41) in Oakland Outer Harbor has a mean hole TKN concentration of 1600±1600 ppm, yet has a mean hole sand content of 43±58 percent. The high deviation from the mean hole TKN concentration is due to the fine shoaled sediment having an extremely high TKN level of 2700 ppm, the highest sample concentration in the Oakland Inner-Outer Harbor area. The deeper undisturbed sandy sediment in this hole has a TKN concentration of 400 ppm. Hole 2D-99(46) in Oakland Inner Harbor is similar to 2D-107(41) in the Outer Harbor in that the fine surface sediment has a high TKN level and the coarse undisturbed sediment has a low TKN level.

Oil-Grease. The mean oil-grease concentration in the Oakland Inner-Outer Harbor area is 700±100 ppm. Oil-grease levels are larger with greater variability than in the San Pablo Bay-Carquinez Strait and San Pablo Strait-Berkeley Flats areas. Oil-grease concentrations in the sediments range from 100 ppm to 5800 ppm. Table 35 is a listing of the mean hole oil-grease concentrations in order of decreasing magnitude.

The highest oil-grease levels of all core samples taken in this study were found in this area. Except for hole 2D-101(47), Oakland Inner Harbor and Tidal Canal have the highest mean hole and sample oil-grease concentrations. Hole 2D-95(44) with the highest mean hole oil-grease concentration of 2500±2200 ppm, also has the highest sample concentration of 5800 ppm. The surface sediments of other Inner Harbor holes have high oil-grease levels regardless of the sand or clay content except for 2D101(47). Deeper samples in the Inner Harbor generally have low oil-grease levels.

TABLE 35

OAKLAND INNER-OUTER HARBOR
MEAN HOLE OIL-GREASE CONCENTRATIONS

Rating	Hole	Mean ppm	Range ppm	% Sand $>74\mu$	% Clay $<2\mu$
1	2D-95(44)	2500±2200	100-5800	3±2	39±4
2	2D-99(46)	1600±1000	300-2700	32±43	22±12
3	2D-94(45)	1300±1100	100-2700	60±21	16±9
4	2D-103(40)	800±500	300-1500	11±14	33±9
5	2D-98(48)	600±500	200-1300	67±22	16±9
6	2D-100(39)	600±700	100-1600	15±14	33±7
7	2D-106(37)	400±400	100-1000	13±14	30±6
8	2D-134(36)	300±200	100-600	52±28	18±9
9	2D-102(43	300±500	100-1200	15±5	26±6
10	2D-105(38)	100±0	100-100	39±29	20±10
11	2D-104(42)	100±0	100-100	88±2	7±2
12	2D-107(41)	100±0	100-100	43±58	28±29
13	2D-101(47)	100±0	100-100	94±2	3±1

The shallow periphery areas have mean hole oil-grease concentrations ranging from 800±500 ppm at 2D-103(40) to 100 ppm at 2D-105(38).

The two holes taken in Oakland Outer Harbor have extremely low oil-grease concentrations.

Mercury. The mean mercury concentration in the Oakland Inner-Outer Harbor area is 0.65±0.56 ppm. This mean is lower than in the San Pablo Bay-Carquinez Strait and San Pablo Strait-Berkeley Flats areas. Mean hole mercury concentrations range from 1.17±1.38 ppm in Emeryville Flats to 0.13±0.05 ppm in Oakland Inner Harbor. Table 36 lists mean hole mercury concentrations in order of decreasing magnitude.

Hole 2D-134(36) in Emeryville Flats has the highest mean hole mercury concentration. The sediments of this hole are among the coarser sediments in this area. The mean sand content is 52±28 percent and the clay content is only 18±9 percent. The high mean hole mercury concentration is due to an extremely high mercury value of 3.9 ppm in the fine clayey silt surface sediments. Mercury levels in this hole generally decrease with depth from a value of 3.9 ppm at the surface to 0.2 ppm in the sandy material at 15 feet below Bay bottom.

TABLE 36

OAKLAND INNER-OUTER HARBOR
MEAN HOLE MERCURY CONCENTRATIONS

Rating	Hole	Mean ppm	Range ppm	% Sand > 74 μ	% Clay <2 μ
1	2D-134(36)	1.17±1.38	0.2-3.9	52±28	18±9
2	2D-103(40)	1.16±0.33	0.7-1.6	11±14	33±9
3	2D-99(46)	0.93±0.45	0.4-1.3	32±43	28±12
4	2D-107(41)	0.90±0	0.9-0.9	43±58	28±29
5	2D-105(38)	0.71±0.29	0.2-1.2	39±29	20±10
6	2D-104(42)	0.65±0.07	0.6-0.7	88±2	7±2
7	2D-102(43)	0.62±0.23	0.4-1.0	15±5	26±6
8	2D-101(47)	0.47±0.12	0.4-0.6	94±2	3±1
9	2D-95(44)	0.44±0.38	0.1-0.9	3±2	39±4
10	2D-100(39)	0.42±0.19	0.1-0.6	15±14	33±7
11	2D-98(48)	0.40±0.29	0.1-0.8	67±22	16±9
12	2D-106(37)	0.32±0.27	0.2-0.8	13±14	30±6
13	2D-94(45)	0.13±0.05	0.1-0.2	60±21	16±9

High mean hole mercury concentrations are also found at 2D-103(40) in Oakland shallows, 2D-99(46) in Oakland Inner Harbor and 2D-107(41) in Oakland Outer Harbor.

Hole 2D-95(44) in Oakland Inner Harbor has the finest sediments in this area, yet has a mean hole mercury concentration of only 0.44±0.38

ppm. 2D-106(37) in the southern periphery shallows also has an extremely low mean hole mercury concentration of 0.32±0.27 ppm for the relatively fine sediments. The surface sediments of 2D-106(37) are the coarsest of the hole, yet the mercury level is highest. Except for this surface sample mercury is uniformly distributed with depth.

The lowest mean mercury concentration is at hole 2D-94(45) in Oakland Inner Harbor with a value of 0.13±0.05 ppm. Lead levels in the sediments are uniformly distributed with depth, varying from 0.2 ppm at the surface to 0.1 ppm at about 4 feet below Bay bottom.

Lead. The mean lead concentration in the Oakland Inner-Outer Harbor area is 43.2±55.3, which is larger than either the San Pablo Bay-Carquinez Strait or San Pablo Strait-Berkeley Flats areas. Table 37 shows the mean hole lead concentrations in order of decreasing magnitude.

TABLE 37

OAKLAND INNER-OUTER HARBOR
MEAN HOLE LEAD CONCENTRATIONS

Rating	Hole	Mean ppm	Range ppm	% Sand >74 μ	% Clay <2 μ
1	2D-94(45)	144.0±128.2	15-264	60±21	16±9
2	2D-95(44)	109.4±91.7	18-237	3±2	39±4
3	2D-99(46)	53.8±29.4	11-74	32±43	22±12
4	2D-107(41)	48.0±55.2	9-87	43±58	28±29
5	2D-103(40)	43.2±9.7	36-60	11±14	33±9
6	2D-100(39)	35.2±21.8	14-58	15±14	33±7
7	2D-98(48)	31.2±24.9	13-73	67±22	16±9
8	2D-106(37)	29.0±22.4	17-69	13±14	30±6
9	2D-102(43)	25.6±22.2	13-65	15±5	26±6
10	2D-134(36)	23.7±17.3	11-58	52±28	18±9
11	2D-105(38)	17.2±4.9	12-25	39±29	20±10
12	2D-104(42)	11.0±5.7	7-15	88±2	7±2
13	2D-101(47)	6.3±2.5	4-9	94±2	3±1

Mean hole lead concentrations range from 144.0±128.2 ppm in Oakland Tidal Canal to 6.3±2.5 ppm in the Oakland Inner Harbor navigation channel. Extremely high lead levels are found at 2D-94(45) and 2D-95(44) in Oakland Inner Harbor. The two uppermost samples of 2D-94(45), representing the first two feet of sediment, have lead values of 264 ppm and 244 ppm.

The sand content of these two samples is greater than 50 percent. Lead levels and sand content in 2D-94(45) decrease with depth. Hole 2D-95(44) also has high levels in the shallower sediments, but the sediments are also very fine. Lead levels of 2D-95(44) decrease from 237 ppm in the surface sediments to 18 ppm at about 7 feet below Bay bottom. The clay content increases with depth from 35 percent at the surface to 43 percent at the bottom of the hole.

Holes 2D-99(46) in Oakland Inner Harbor and 2D-107(41) in the Outer Harbor have fairly high mean hole lead concentrations when compared to the mean hole sand content. The high mean hole lead levels are due to the low sand content in the surface sediments which represent shoaled sediments in the navigation channel. The deeper undisturbed sandy sediments have very low lead levels.

Except for 2D-103(40) the mean hole lead concentrations in the shallow periphery areas are low. The surface sediments are enriched with lead and decrease to very low levels with depth.

The lowest mean hole lead levels are found at 2D-104(42) and 2D-101(47) in the undisturbed sandy sediments of Oakland Inner and Outer Harbor. The lead levels in these two holes vary from 4 ppm to 15 ppm.

<u>Zinc</u>. The mean zinc concentration in the Oakland Inner-Outer Harbor area is 107.8 ± 91.2 ppm, which is less than either the San Pablo Bay-Carquinez Strait and San Pablo Strait-Berkeley Flats area. Zinc levels range from 17 ppm in the undisturbed sandy sediments of Oakland Inner Harbor to 386 ppm in the fine clayey silt sediments of the Inner Harbor. Table 38 is a listing of the mean hole zinc concentrations in order of decreasing magnitude.

As with lead, the highest mean hole zinc concentrations are found in Oakland Inner Harbor and Tidal Canal. Hole 2D-95(44) has the finest sediments in Oakland Inner Harbor and also has the highest mean hole zinc concentration of 343.8 ± 126.4 ppm. Zinc levels in the sediments of this hole range from 115 ppm to 386 ppm. The highest zinc concentrations with values greater than 300 ppm are found in the upper four feet of sediment. Between 5 and 7 feet below Bay bottom the sediments become slightly finer but the zinc levels decrease to 115 ppm. Hole 2D-94(45) in the Tidal Canal has very high zinc levels associated with the coarse surface sediments. Zinc levels decrease from 327 ppm in the surface sediments to 59 ppm at about four feet below Bay bottom.

TABLE 38

OAKLAND INNER-OUTER HARBOR
MEAN HOLE ZINC CONCENTRATIONS

Rating	Hole	Mean ppm	Range ppm	% Sand >74 μ	% Clay <2 μ
1	2D-95(44)	343.8±126.4	115-386	3±2	39±4
2	2D-94(45	216.0±134.0	59-328	60±21	16±9
3	2D-99(46)	178.5±104.4	32-256	32±43	22±12
4	2D-100(39)	131.4±55.5	52-196	15±14	33±17
5	2D-107(41)	117.5±118.1	34-201	43±58	28±29
6	2D-103(40)	116.2±42.3	69-177	11±14	33±9
7	2D-106(37)	112.4±19.5	92-144	13±14	30±6
8	2D-98(48)	93.4±78.4	34-213	67±22	16±9
9	2D-102(43)	64.4±24.6	51-105	15±5	26±6
10	2D-134(36)	53.5±32.0	23-112	52±28	18±9
11	2D-105(39)	39.3±12.1	27-63	39±29	20±10
12	2D-101(47)	28.7±10.1	17-35	94±2	3±1
13	2D-104(42)	27.5±10.6	20-35	88±2	7±2

Hole 2D-107(41) in Oakland Outer Harbor has a mean hole zinc concentration of 117.5±118.1. The surface sediment of this hole, representing fine shoaled sediments has a zinc concentration of 201 ppm. The deeper undisturbed sand has a zinc level of 34 ppm.

The lowest mean zinc concentrations are again found in the undisturbed sandy material of Oakland Inner and Outer Harbor. In these areas zinc levels vary from 17 ppm to 35 ppm.

Cadmium. The mean cadmium concentration in the Oakland Inner-Outer Harbor area is 0.95±0.92 ppm. The mean in this area is the same as in the San Pablo Strait-Berkeley Flats area and higher than in the San Pablo Bay-Carquinez Strait area. The mean hole cadmium concentrations are higher in the fine shoal sediments of Oakland Inner Harbor and the lowest mean hole concentrations are found in the sandy undisturbed sediments of the Inner and Outer Harbor. Table 39 lists the mean hole cadmium concentrations in order of decreasing magnitude.

The highest mean hole cadmium concentrations are found at 2D-95(44) and 2D-94(45) in Oakland Inner Harbor Channel and Tidal Canal. Cadmium

levels in 2D-95(44) vary from 0.8 ppm to 6.6 ppm. Extremely high cadmium levels are found in the first four feet of sediment varying from 1.5 ppm at the surface to 6.6 ppm at about four feet below Bay bottom. Cadmium levels then decrease to 0.8 ppm between 4 and 7 feet below Bay bottom. This hole is entirely clayey silt. Hole 2D-94(45) has a mean hole cadmium concentration of 1.45±0.89 ppm. Cadmium levels in the coarse surface sediments are very high, ranging from 2.1 ppm to 2.3 ppm. Cadmium levels decrease to 0.5 ppm at about 4 feet below Bay bottom.

TABLE 39

OAKLAND INNER-OUTER HARBOR
MEAN HOLE CADMIUM CONCENTRATIONS

Rating	Hole	Mean ppm	Range ppm	% Sand $>74\mu$	% Clay $<2\mu$
1	2D-95(44)	2.26±2.46	0.8-6.6	3±2	39±4
2	2D-94(45)	1.45±0.89	0.5-2.3	60±21	16±9
3	2D-107(41)	1.20±0.7	0.7-1.7	43±58	28±29
4	2D-106(37)	1.14±0.11	1.0-1.3	13±14	30±6
5	2D-100(39)	0.92±0.30	0.5-1.3	15±14	33±17
6	2D-103(40	0.90±0.1	0.8-1.0	11±14	33±9
7	2D-99(46)	0.83±0.59	0.2-1.5	32±43	22±12
8	2D-98(48)	0.80±1.34	0.1-3.2	67±22	16±9
9	2D-134(36)	0.77±0.25	0.5-1.1	52±28	18±9
10	2D-102(43)	0.74±0.09	0.6-0.8	15±5	26±6
11	2D-105(38)	0.64±0.22	0.4-1.1	39±29	20±10
12	2D-104(42)	0.35±0.21	0.2-0.5	88±2	7±2
13	2D-101(47)	0.17±0.06	0.1-0.2	94±2	3±1

The high mean hole cadmium concentration of 2D-107(41) in the Outer Harbor channel is due to a high level of 1.7 ppm in the fine surface shoal material of the hole.

Hole 2D-102(43) in the periphery shallows just south of the Bay Bridge has a mean hole cadmium concentration of 0.74±0.09 ppm. Cadmium levels vary from 0.6 ppm to 0.8 ppm. These low cadmium levels are associated almost entirely with clayey silt.

The lowest mean hole cadmium concentrations, like with the other contaminants are found in the sandy undisturbed sediments of 2D-101(47)

in Oakland Inner Harbor and 2D-104(42) in Oakland Outer Harbor. 2D-104(42) has a mean hole cadmium concentration of 0.35±0.21 ppm and 2D-101(47) has a mean concentration of 0.17±0.06 ppm.

Copper. The mean copper concentration in the Oakland Inner-Outer Harbor area is 35.8±28.8 ppm. This is lower than in the San Pablo Strait-Berkeley Flats area but higher than in the San Pablo Bay-Carquinez Strait area. Mean hole copper concentrations in this area vary from 91.4±41.6 ppm in the fine shoal sediments of Oakland Inner Harbor to 7.0±1.0 ppm in the undisturbed sediments of Oakland Inner Harbor. Table 40 is a listing of mean hole copper concentrations in order of decreasing magnitude.

TABLE 40

OAKLAND INNER-OUTER HARBOR
MEAN HOLE COPPER CONCENTRATIONS

Rating	Hole	Mean ppm	Range ppm	% Sand > 74 μ	% Clay <2 μ
1	2D-95(44)	91.4±41.6	46-136	3±2	39±4
2	2D-99(46)	63.5±41.1	6-95	32±43	22±12
3	2D-94(45)	44.3±25.5	14-73	60±21	16±9
4	2D-103(40)	44.0±8.9	29-52	11±14	33±9
5	2D-100(39)	41.2±16.5	21-60	15±14	33±17
6	2D-107(41)	35.0±41.0	6-64	43±58	28±29
7	2D-106(37)	31.8±6.1	24-41	13±14	30±6
8	2D-102(43)	30.2±9.9	23-47	15±5	26±6
9	2D-98(48)	27.0±24.5	7-64	67±22	16±9
10	2D-134(36)	18.7±12.0	8-41	52±28	18±9
11	2D-105(38)	18.2±4.4	13-25	39±29	20±10
12	2D-104(42)	11.0±4.2	8-14	88±2	7±2
13	2D-101(47)	7.0±1.0	6-8	94±2	3±1

The highest mean hole copper concentration of 91.4±41.6 ppm is found at 2D-95(44) in the fine sediments of Oakland Inner Harbor. Copper levels in this hole vary from 46 ppm to 136 ppm. High mean hole copper concentration of 63.5±41.1 ppm is also found at 2D-99(46) in the Inner Harbor Channel. Copper levels generally decrease with depth from 95 ppm in the clayey silt surface sediments to 6 ppm in the sandy sediments at about 7 feet below Bay bottom.

The lowest mean hole copper concentrations are found in the undisturbed sandy sediments of 2D-104(42) in Oakland Outer Harbor and 2D-101(47) in Oakland Inner Harbor.

SUMMARY

Contaminant levels within the Oakland Inner-Outer Harbor area, as with the other two areas, vary widely both spatially and temporally. The surface sediments of the area are enriched with all nine contaminants. There is a definite relationship between contaminant levels and sediment type (particle size) which is reflected in both the vertical and horizontal distribution of fine sediments. In a few isolated cases, such as in the Oakland Tidal Canal, extremely high contaminant levels may be associated with coarse sediments.

The spatial distribution of contaminants generally reflect the contemporary environment of deposition. The fine surface sediments of Oakland Inner-Outer Harbor, representing shoal material in the maintained navigation channel, have the highest levels of most of the nine contaminants. Where these fine shoal sediments are absent, however, the surface sediments have extremely low contaminant levels. The coarse surface sediments in the Inner-Outer Harbor are believed to be historical sand deposits that have not been disturbed by dredging. The surface sediments of the one hole drilled in the Oakland Tidal Canal is of interest since the Tidal Canal has not been dredged for a number of years. The surface sediments are very coarse (88 percent sand); yet the contaminant levels are very high. Mercury levels, unlike the other contaminants in the surface sediments of the Inner Harbor, are very low. The surface sediments of the periphery areas outside Oakland Inner-Outer Harbor generally have lower contaminant levels and the spatial distribution is more variable. Contaminant levels in the surface sediments of the shallow periphery areas are higher than in the deeper areas. Higher mercury levels are also found over much of the periphery area than in Oakland Inner and Outer Harbor.

The vertical distribution of contaminants in the Oakland Inner-Outer Harbor area follows the same general trend as in San Pablo Bay-Carquinez Strait. Generally, the highest contaminant levels are associated with the finest sediments. Where the sand and clay content of the sediments vary widely with depth, the contaminant levels also vary greatly.

The Oakland Inner-Outer Harbor area is categorized into two sub-areas according to the geographical location, distribution of contaminants in the sediments and physical characteristics of the area. These sub-areas are Oakland Inner-Outer Harbor navigation channels and the periphery areas outside Oakland Inner-Outer Harbor.

<u>Oakland Inner and Outer Harbor Channels</u>

The area encompasses Oakland Inner-Outer Harbor navigation channels and the Oakland Tidal Canal. Six holes are located in this sub-area;

2D-94(45) in the Oakland Tidal Canal; 2D-95(44), 2D-98(48), 2D-99(46), and 2D-101(47) in the Inner Harbor navigation channel; and, 2D-104(42) and 2D-107(41) in the Outer Harbor navigation channel.

This area is characterized as uniformly low energy environment where the bottom depths, for the most part, have been deepened by dredging. Wind wave action is very low because of the enclosed nature of the harbor. Current velocities are small and water circulation is slight. The area has two types of sediments. Clayey silt found in the surface sediments over much of the area represents the contemporary low energy environment of deposition. These are the sediments normally dredged during maintenance dredging operations. Clayey silt can also be found with depth in certain areas, such as in the central portion of Oakland Inner Harbor near Government Island. Sandy material is found at depth over much of the Inner and Outer Harbor. These are historical repository deposits representing a higher energy environment of deposition at some time in the geologic past.

Contaminant levels in the fine surface sediments are generally very high. Levels are generally very low in the deeper sandy deposits. Hole 2D-99(46) is an example of the distribution of contaminants in the fine surface sediments and coarse deep sediments. The fine sediments extend to a depth of about 5 feet below Bay bottom and are underlain by a very sandy material. Contaminant levels in these surface sediments are very high and decrease to very low levels in the sandy material.

Moving up Oakland Inner Harbor towards Government Island, the sandy sediments are no longer present. The sediments are principally a clayey silt and the contaminant levels are very high. Hole 2D-95(44) is an example of the vertical distribution of contaminants in such an area. Not only are the contaminant levels very high, but there is also a high degree of variability in contaminant levels. The lower levels are found at deeper depths.

Periphery Areas

The periphery areas around Oakland include the relatively shallow water off the entrance to Oakland Inner-Outer Harbor and the shallow areas opposite the city of Emeryville. Six holes are located in this area; 2D-100(39) and 2D-106(37) just south of the entrance to Oakland Inner Harbor; 2D-102(43) and 2D-103(40) between Oakland Outer Harbor and the Bay Bridge; and 2D-105(38) and 2D-134(36) just north of the Bay Bridge. The area is characterized as an intermittently moderate environment of deposition. The sediments vary from clayey silt to silty sand with very gross bedding similar to the sediments of the southern shallows of the San Pablo Bay.

Typical distributions of contaminants in the periphery areas of Oakland are shown in Holes 2D-105(38) and 2D-100(39). Contaminant levels, with the exception of mercury, are lower than the fine shoal sediments of Oakland Inner-Outer Harbor, but greater than the coarse undisturbed sediments. A large variation of most contaminants occurs with depth, mainly due to the variations in sediment types.

CONTAMINANT LEVEL ASSOCIATED WITH PARTICLE SIZE

Bulk chemical analysis of sediments represents a physical condition associated internally (chemical make up of the sediment) and externally (natural or anthropogenic sources) with the sediment. The concentrations of contaminants in the sediment are the results of chemical interactions of the sediment, water, contaminants, organics and organisms. The contaminants can be part of the mineral of the particle, on the surface or between crystals of the particle, as precipitates, bound to organics, as free metals or in solution in the interstitial water.

Results of semiselective extraction scheme (Ref. 36) indicated that a significant portion of the investigated elements was in the residual phase, that is, directly associated with the mineral particle. Seventy-seven percent of the mercury, 60 percent of the iron, 54 percent of the manganese and zinc, 53 percent of the copper, 50 percent of the lead and 4 percent of the cadmium were found in the residual phase.

Trace metals and organics are generally associated with clays and colloidal particles because of large surface area and sorptive characteristics. Figures 47 through 55 are triangular coordinate plots of the sample obtained during this study. The location of the point on the plot gives a soils classification for the sample as indicated on the upper left plot on Figure 47. The size of the circle gives the concentration of the contaminant.

The concentration of large circles in the clayey silt and silty clay regions does verify the association of contaminants with fines. The spread or scatter of large circles along the clay axis, however, shows that source of contaminant has an affect on levels with a given sediment type. As the sediment types become courser, contaminant concentrations generally decrease. An exception to this are samples from hole 2D-94(45) at the Tidal Canal in the Oakland Inner Harbor. The surface sample with 88 percent sand has elevated levels in seven of the nine parameters. The second sample from that hole with 57 percent sand also shows elevated levels when comparing it to other similar sediment types.

Although specific examples can be shown where contaminants are higher than expected with a given type of sediment, the analysis is strictly qualitative. The evaluation must consider the type of sediment deposit and probable sources of contaminants.

TRILINEAR GRAIN SIZE - CONTAMINANT RELATIONSHIPS

ZINC

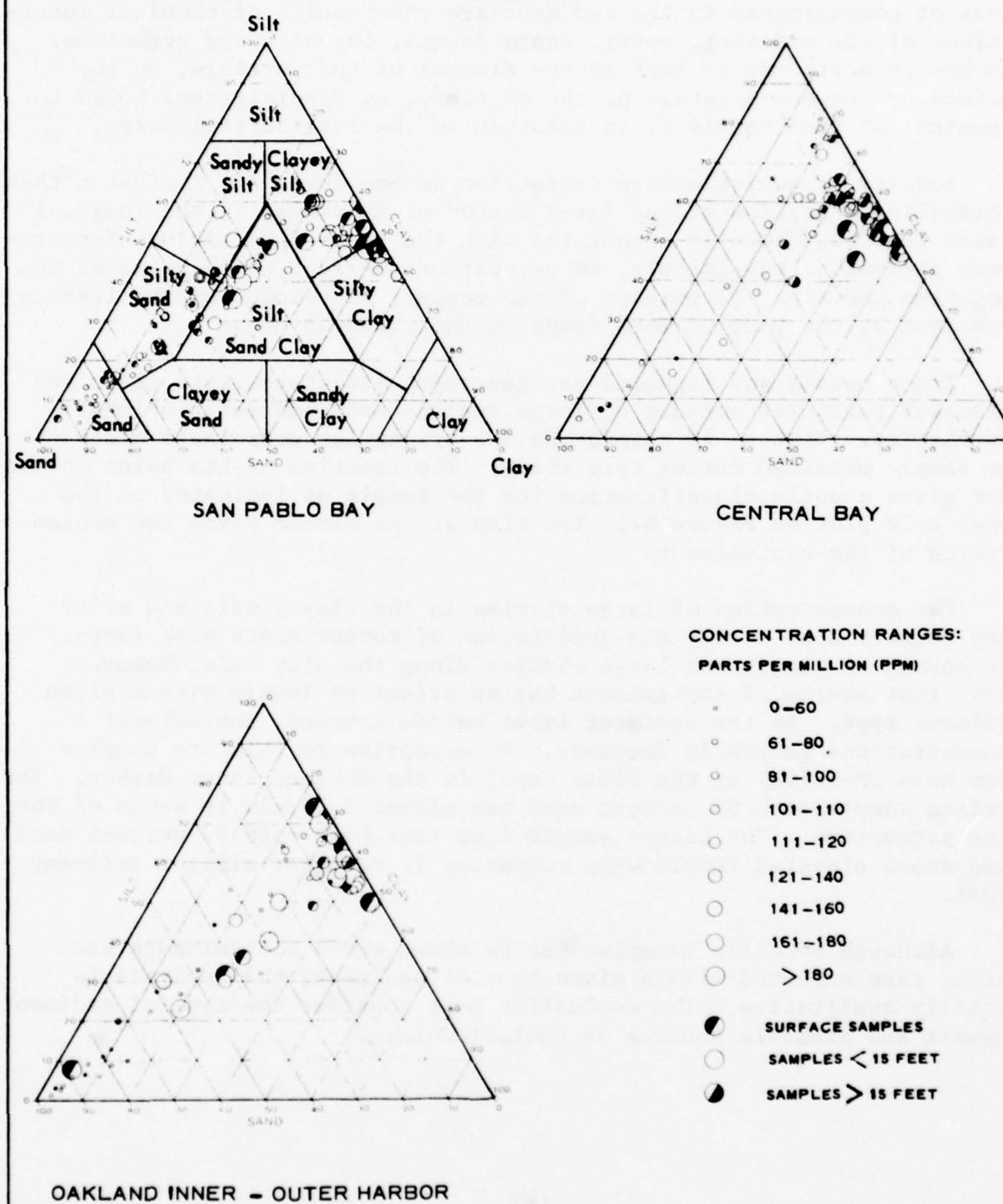


FIGURE 47

TRILINEAR GRAIN SIZE – CONTAMINANT RELATIONSHIPS

COPPER

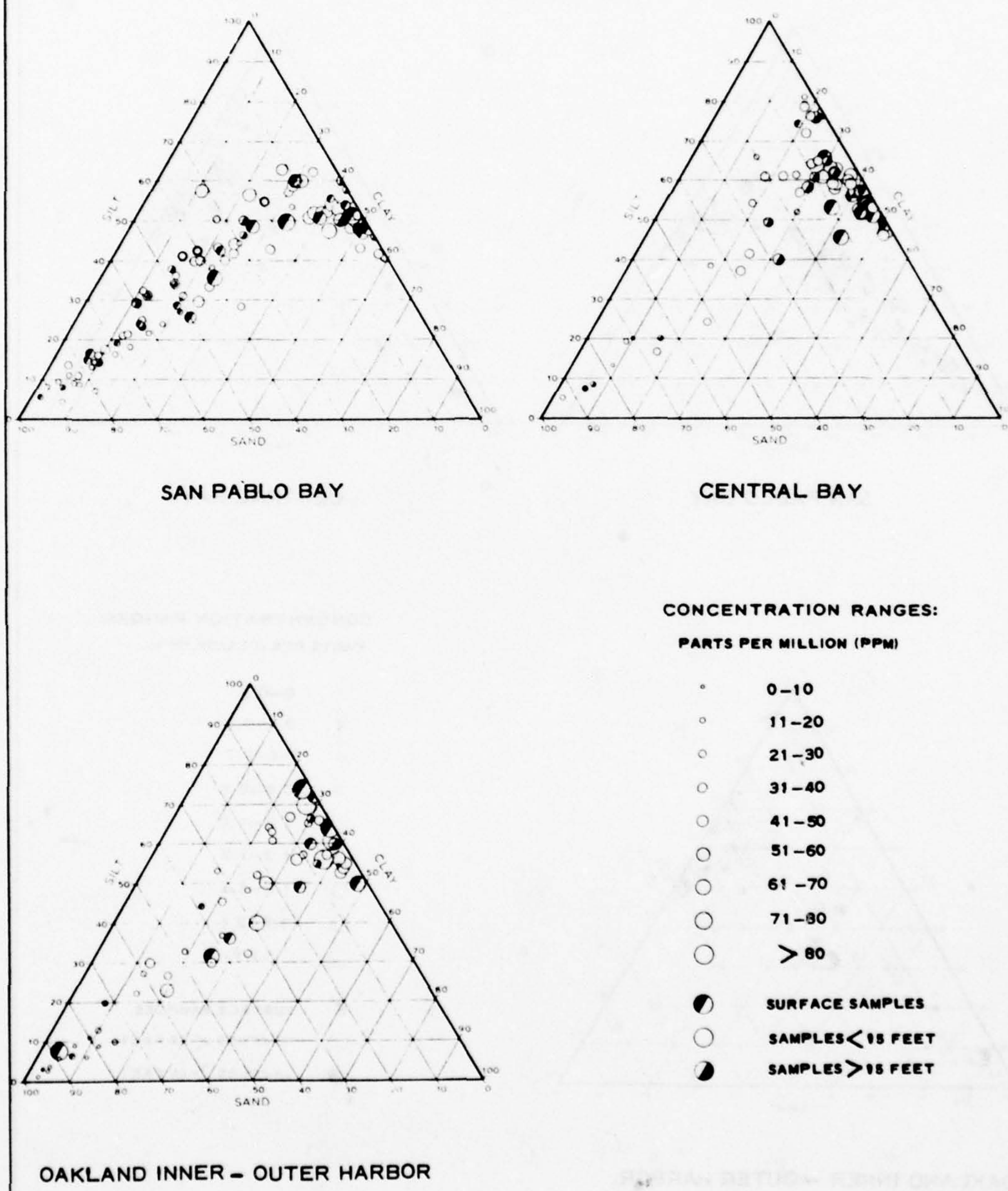


FIGURE 48

TRILINEAR GRAIN SIZE-CONTAMINANT RELATIONSHIPS

CADMIUM

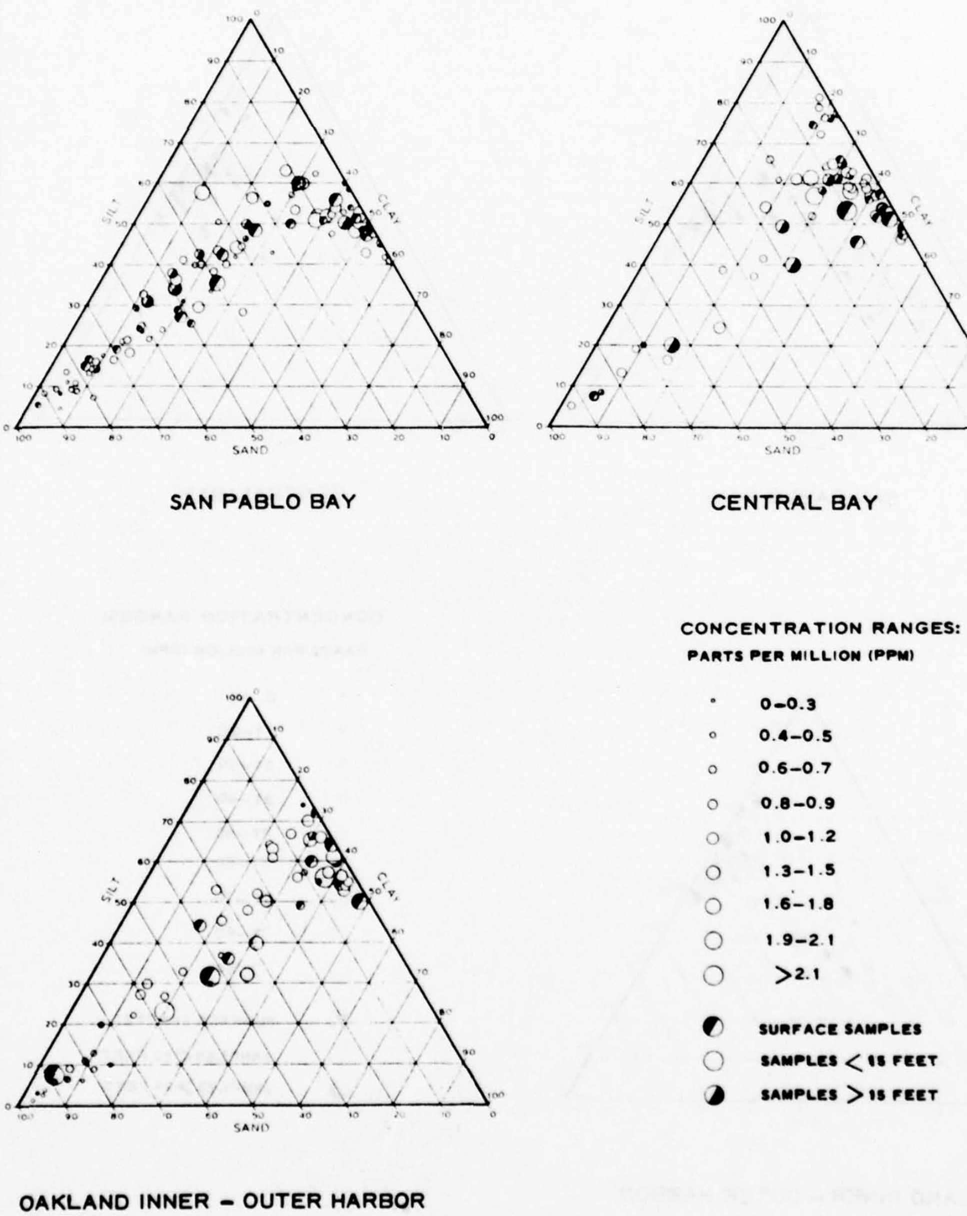


FIGURE 49

TRILINEAR GRAIN SIZE-CONTAMINANT RELATIONSHIPS

LEAD

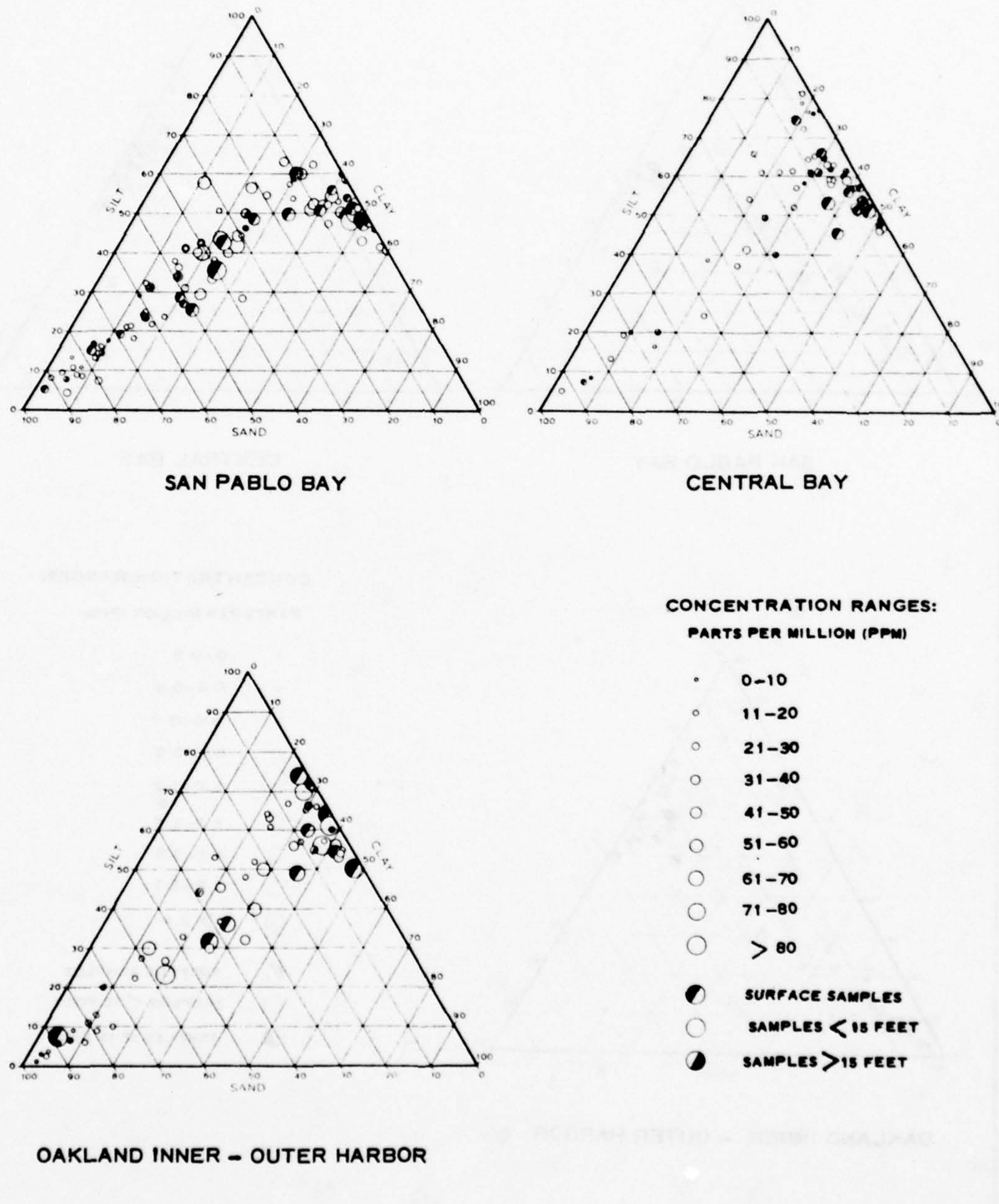


FIGURE 50

TRILINEAR GRAIN SIZE–CONTAMINANT RELATIONSHIPS

MERCURY

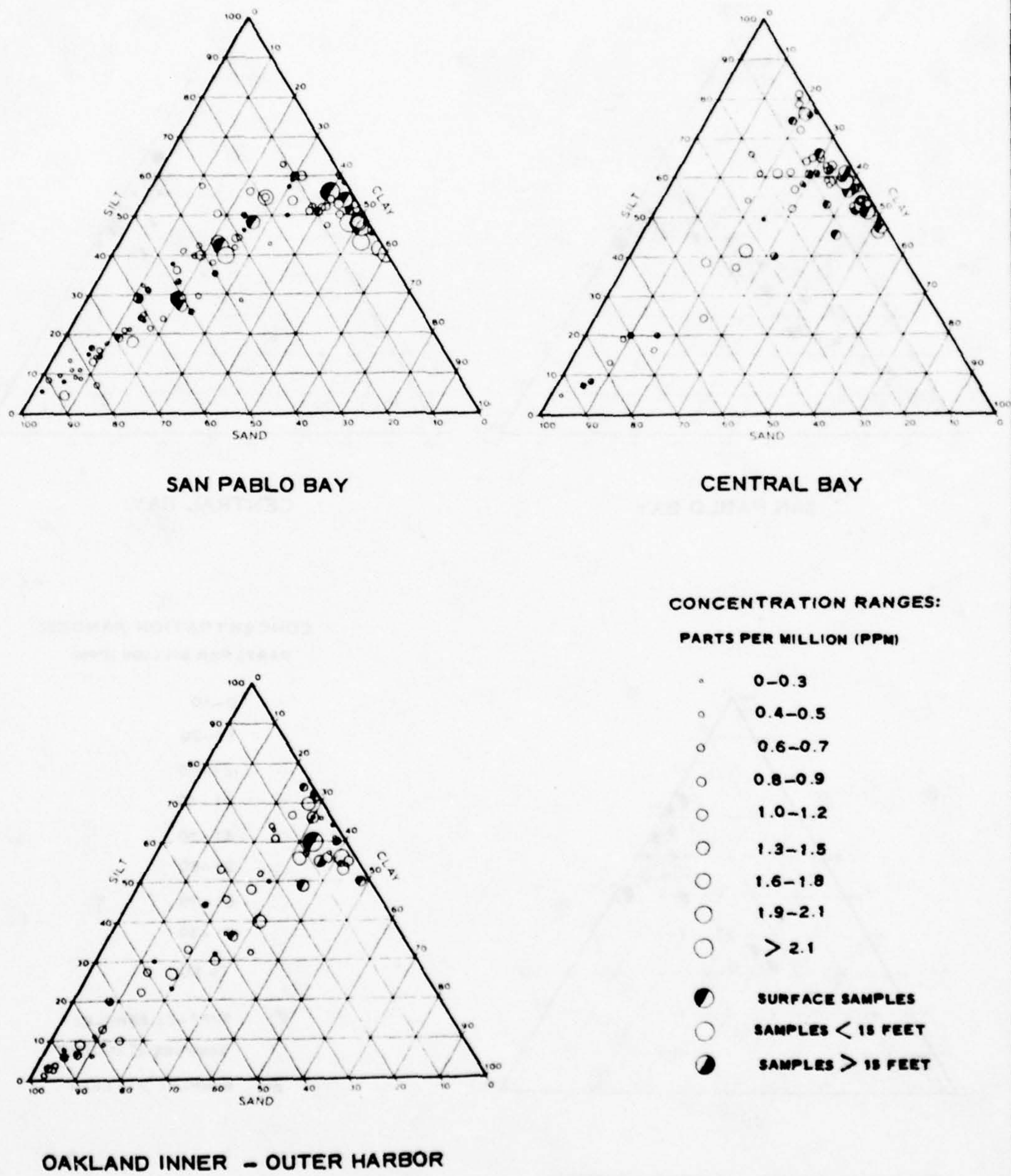


FIGURE 51

TRILINEAR GRAIN SIZE- CONTAMINANT RELATIONSHIPS

VOLATILE SOLIDS

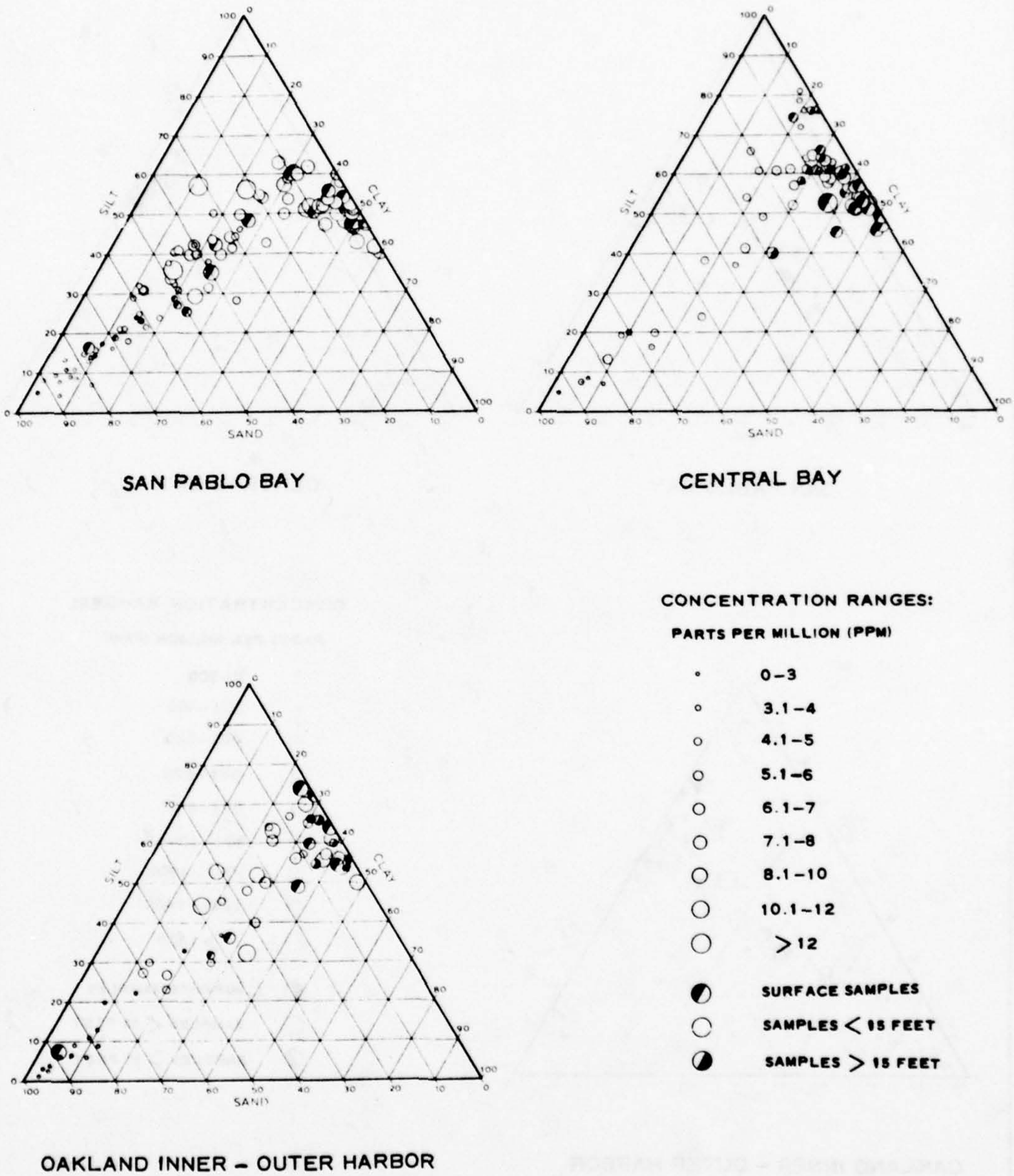
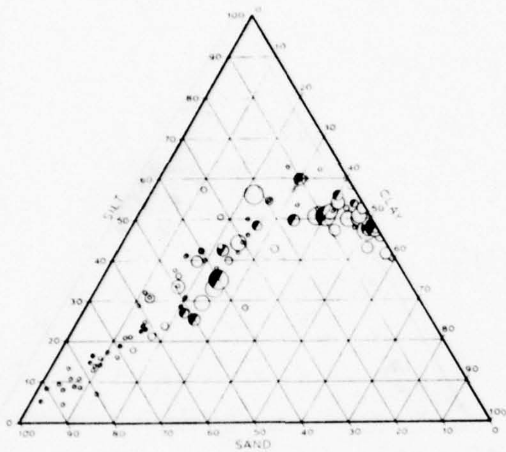


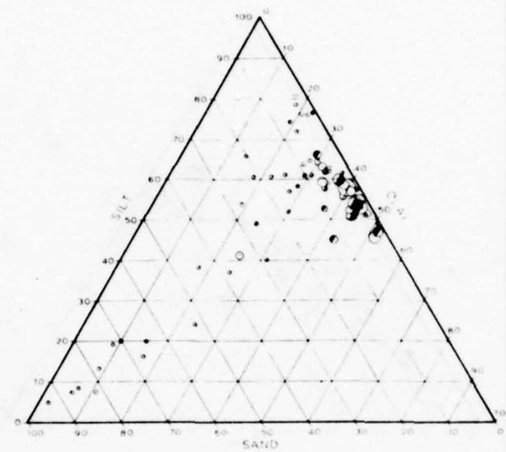
FIGURE 52

TRILINEAR GRAIN SIZE-CONTAMINANT RELATIONSHIPS

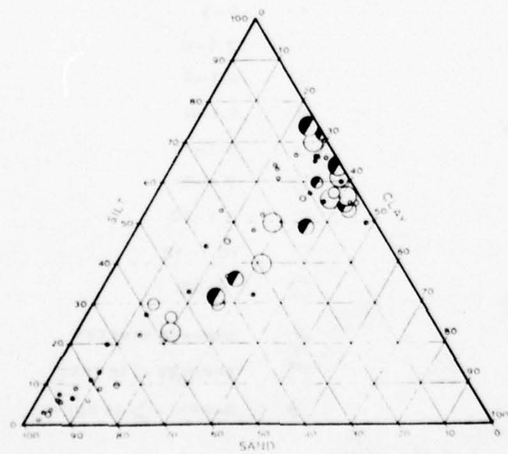
OIL AND GREASE



SAN PABLO BAY



CENTRAL BAY



OAKLAND INNER – OUTER HARBOR

CONCENTRATION RANGES:

PARTS PER MILLION (PPM)

- 0–300
- 301–400
- 401–500
- 501–600
- 601–800
- 801–1000
- 1001–1200
- 1201–1400
- >1400

- SURFACE SAMPLES
- SAMPLES < 15 FEET
- SAMPLES > 15 FEET

FIGURE 53

TRILINEAR GRAIN SIZE – CONTAMINANT RELATIONSHIPS

CHEMICAL OXYGEN DEMAND

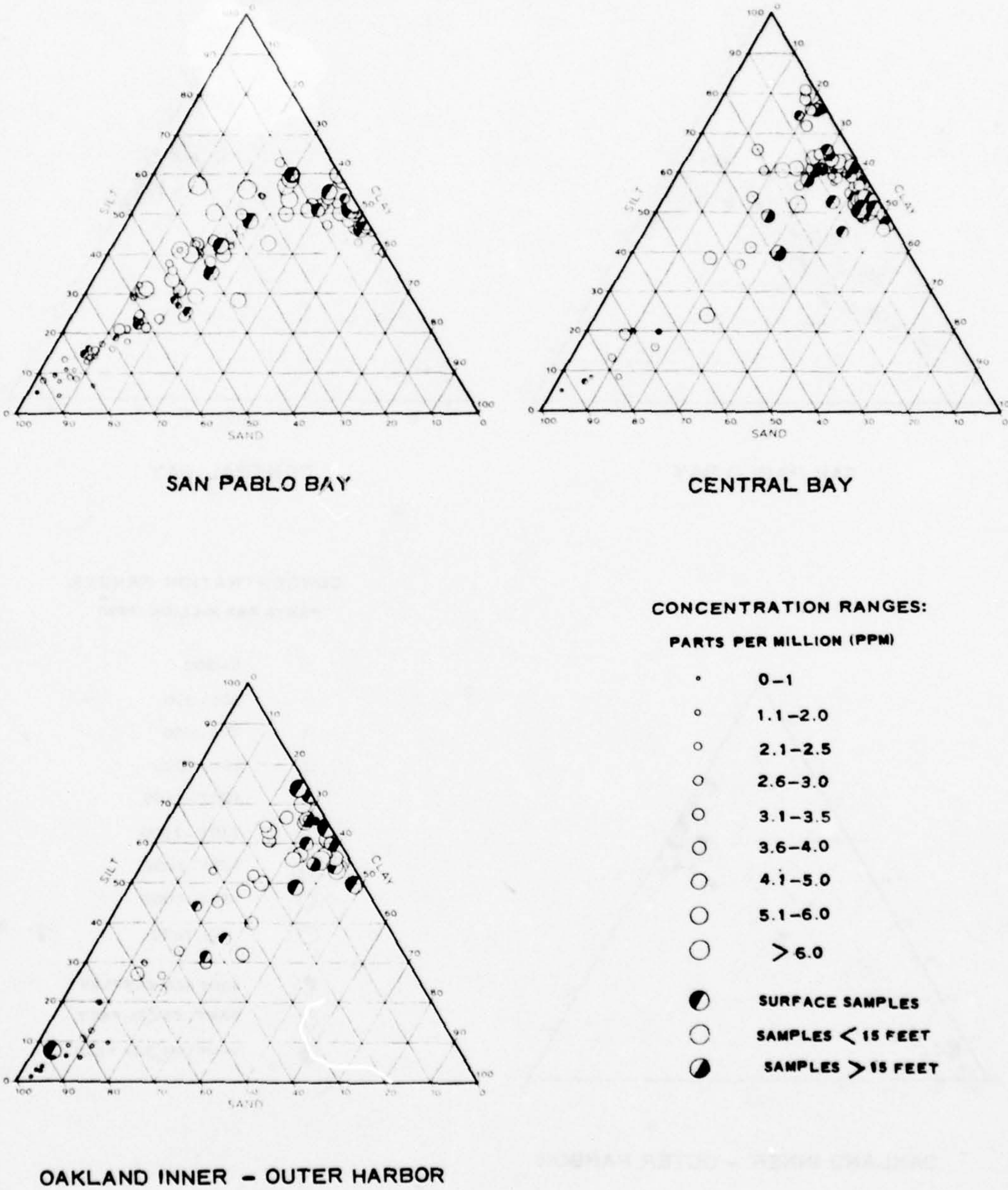


FIGURE 54

TRILINEAR GRAIN SIZE — CONTAMINANT RELATIONSHIPS

TOTAL KJELDAHL NITROGEN

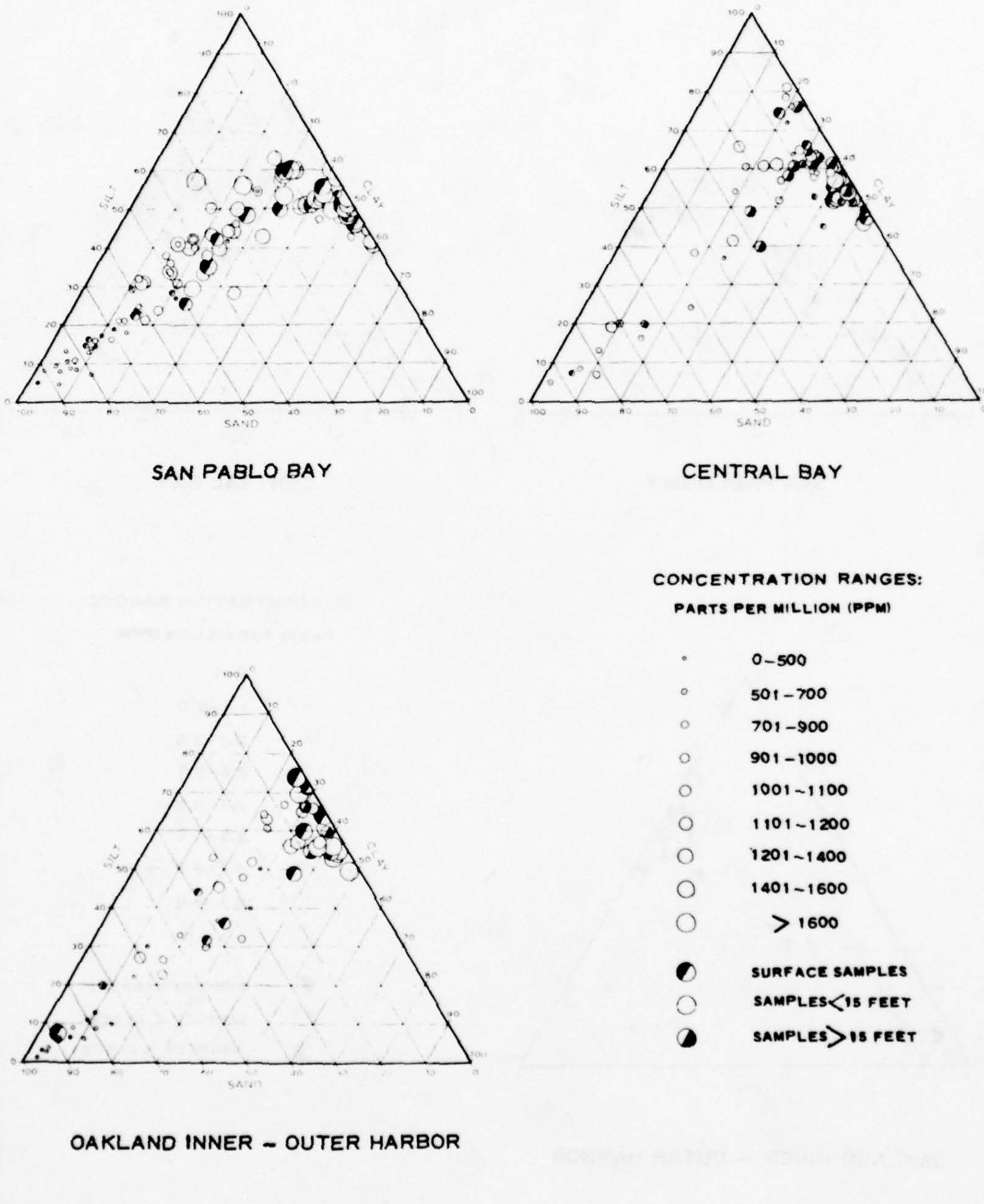


FIGURE 55

TIME RELATIONSHIPS OF CONTAMINANT LEVELS

The major objective of the pollutant distribution study was the spartial distribution of contaminants in the Bay. The analysis included samples from 1970 through 1974. During the delay in publishing the study, additional samples were taken on a routine basis for the various Federal projects in the Bay. The data, including both bulk sediment analysis and elutriate analysis are appended to Inclosure 1.

Data covering about seven years is now available on the bulk analysis of sediments associated with Corps projects in San Francisco Bay. Three projects, Mare Island Strait, Richmond Harbor and Oakland Outer Harbor were evaluated for temporal variations of contaminants. Figure 56 presents the average and standard deviation for each set of samples on oil-grease, mercury, cadmium, lead, and zinc.

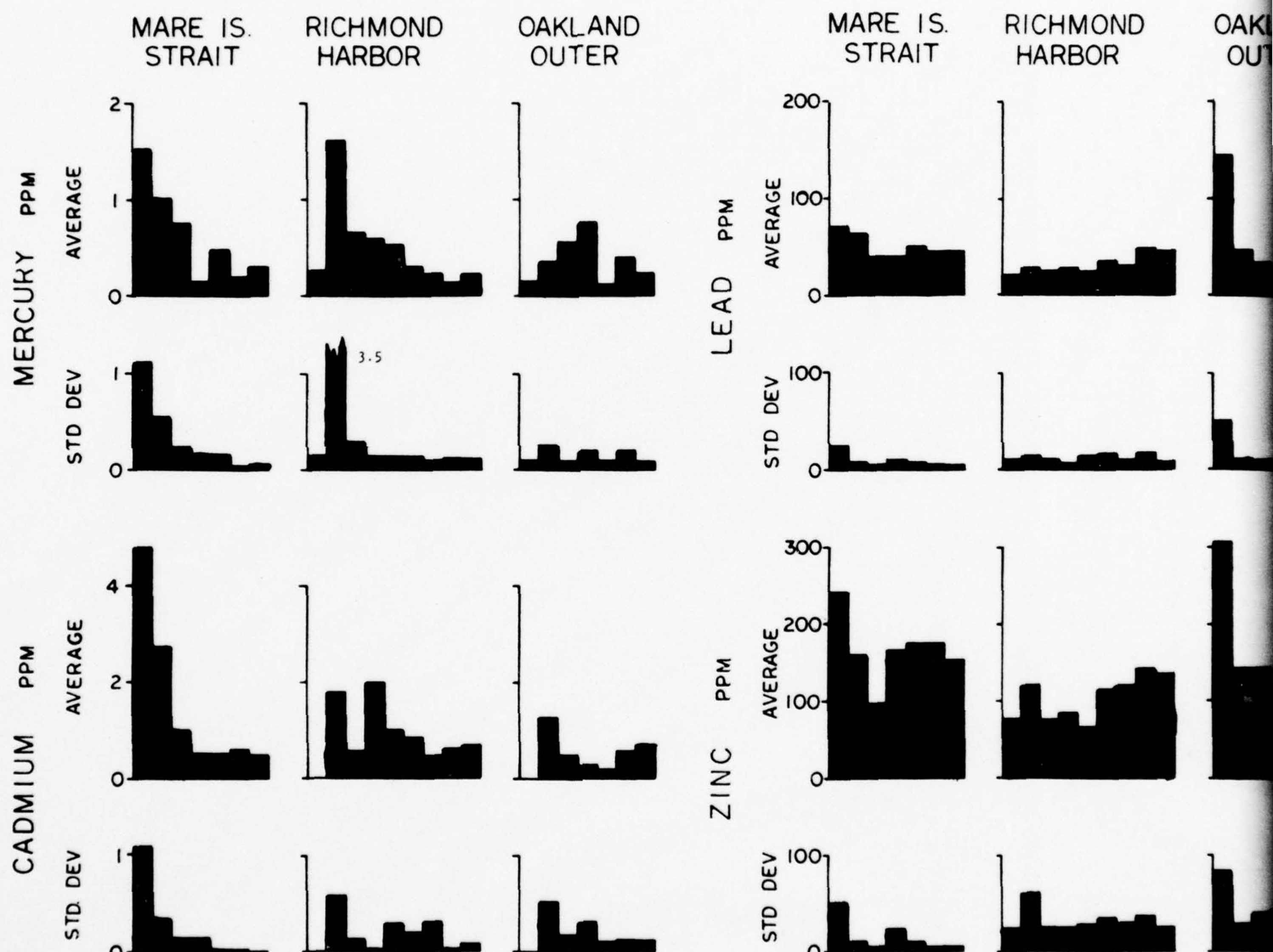
In Mare Island Strait, all five contaminants show a decreasing trend with mercury and cadmium having major decrease. The standard deviation also shows a decreasing trend.

Richmond Harbor does not show the same consistent trends of Mare Island Strait. Mercury and cadmium show decreases while lead and zinc show increases. The average of all five contaminants for the two projects appears to be converging. For the latest data sets, the averages are about the same with the exception of zinc.

The data for Oakland Outer Harbor do not show trends except that the standard deviation (variation of sample within the average) for all parameters show a decreasing trend.

Table 41 compares the average from the period 1970-1974 to the most recent data from the three project areas.

Spatial analysis of contaminant levels at the Alameda Naval Air Station showed concentration contours associated with a storm drain (Ref. 37). The subsequent sampling period, which was proceeded by controls on the point source and a dredging operation, showed major reductions in contaminants concentrations. Since initiation of sediment sampling, improvements have been made in controlling point sources in the Bay. The water quality in the Bay has been significantly improved in the last ten years. With the sediments scavaging the water column of contaminants, reduced levels of contaminants would be expected to occur in sediments within the dynamic regime of the Bay. Based on the corings in this study and the studies of sediment release and transport (Ref. 38, 39 and 40) large quantities of sediment are in transport with the general movement into Central Bay and eventually out the Golden Gate.



MARE IS. STRAIT
RICHMOND HARBOR
OAKLAND OUTER
MERCURY PPM
AVERAGE
STD DEV
3.5
CADMIUM PPM
LEAD PPM
ZINC PPM

	MARE IS. STRAIT		RICHMOND HARBOR		OAKLAND OUTER
DATA BASE TIME	**SAMPLES**	**TIME**	**SAMPLES**	**TIME**	**SAMPLES**
1972	24	1971	41	1971	8
1974	19	1972	15	1972	12
1975	19	JUN 1974	61	1974	26
1976	41	JUL 1974	10	1975	11
1977	20	AUG 1974	50	1976	7
JUL 1978	6	1975	19	1977	6
SEP 1978	11	1976	17	1978	6
		1977	14		
		1978	11		

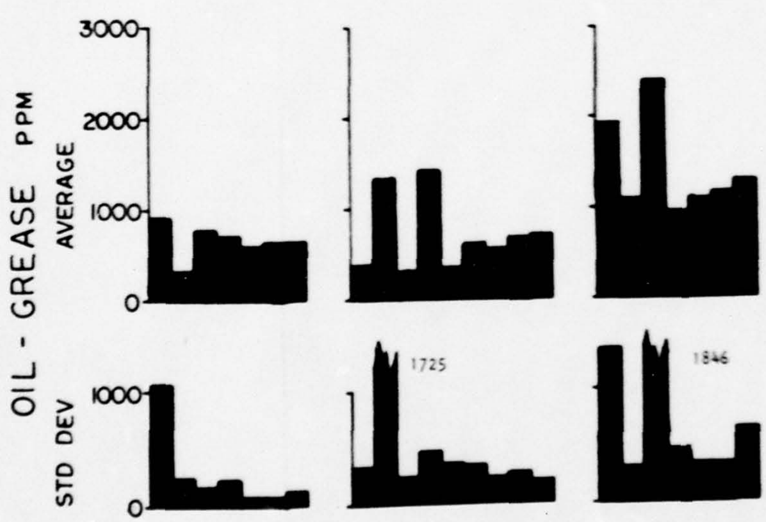


FIGURE 56

TABLE 41

TEMPORAL CHANGES IN CONTAMINANT LEVELS

	Oil-Grease	Mercury	Cadmium	Lead	Zinc
Mare Island Strait					
1970-1974	800	0.56	2.69	58.8	193.3
1978	638	0.30	0.50	44.7	152.8
% Change	80	54	19	76	79
Richmond Harbor					
1970-1974 (Outer)	600	0.46	1.24	28.3	98.0
1970-1974 (Inner)	500	0.40	1.69	23.9	90.9
1978	725	0.22	0.66	43.0	136
% Change	132	51	45	165	144
Oakland Outer Harbor					
1970-1974	1,400	0.46	1.45	49.3	136.1
1978	1,300	0.23	0.71	55.8	147.0
% Change	93	50	49	113	108

The reason for increases in Richmond Harbor and Oakland Outer Harbor is not known. A possible explanation is the slower shoaling rate associated reduce Delta outflow during the two years of drought. What sediments were accumulating had longer exposure times to nonpoint source input of contaminant. The sediments in Richmond and Oakland Outer Harbor are coarser than Mare Island Strait and have a greater susceptibility for resuspension. The periodic resuspension would also increase the exposure time.

Another factor may be slight change in particle size because of the drought. No detailed sampling for a grain size analysis, however, is available. A small interval sediment sample program following the first major rains after the drought may have provided some insight into the question. No major change in standard deviation occurred with the last sampling periods which tends to indicate that the increases were probably not a point discharge. Analysis of maintenance dredging sediments over time may provide a more stable basis for evaluating contaminants in the estuarine system than water measurements.

SUMMARY AND CONCLUSION

INTRODUCTION

The San Francisco Bay system encompasses an area of 460 square miles and has a tributary area of 62,920 square miles. The system is a series of large bays interconnected by constricted straits. Seventy percent of the Bay is less than 18 feet in depth. The importance of this area as a terminus for waterborne commerce and its shallowness requries the dredging of waterways linking the major ports to deep water. Presently, about 10 million cubic yards of Bay sediments are dredged annually by the Federal Government, local and private concerns for maintaining these navigation channels.

Sediments subject to dredging are largely composed of the fine silt-clay-colloidal size fractions. The electronegative charge of dispersed clay colloidals and their highly exposed surface areas permit the sorption (attachment) of large numbers of cations. Because the sorptive characteristics of most contaminants are great and clay particles have large specific surfaces with electronegative charges, dredged sediments invariably contain concentrations of trace metals and organics at levels many times higher than the small quantities found in water. Contaminants, when attached to marine sediments, behave as the sediments, so when dredging and disposal operations resuspend and disturb the bottom sediment regimen, contaminants are also disturbed and may become available to benthic and aquatic communities.

The association of contaminants with bottom sediments is dependent on the physical sedimentary characteristics of the estuary and the forces that distribute the sediments. Transportation and deposition of fine sediments and sorbed contaminants involve complex relationships such as tidal flow velocities and mixing characteristics, suspension concentrations and deposition patterns. Concentration of any given contaminant in San Francisco Bay sediments differs greatly both spatially and temporally.

PHYSICAL ESTUARINE PROCESSES

Contaminants enter the San Francisco Bay system through natural weathering processes of rocks and soils and by anthropogenic means on land, air and water. The estuary is a sink or settling basin for all upstream discharges or discharges directly into the estuary. Contaminant concentrations depend on the estuary's ability to assimilate or disperse the contaminants. The estuary is a complex system of interacting forces such as winds, currents and tides, and physical factors such as geography which dictate contaminant distribution.

Distribution of contaminants depends on energy gradients - contaminants move from zones of higher energy to zones of lower energy within the Bay system. Tides, waves, and currents are the physical forces most responsible for eroding, transporting and depositing sediments within the San Francisco Bay system.

CONTAMINANT SOURCES

Solid waste substances and dissolved waste materials are introduced in suspended form into the Bay. Dissolved substances are sorbed by particulate matter (sediments) both before entry and after entry into the estuary. These organic and inorganic contaminants show behavior and distribution patterns similar to that of natural sediments. Contaminated sediments accumulate in certain deposition zones within the Bay system. Contaminants when attached to natural sediments are found in areas subject to maintenance dredging by the Corps of Engineers and others.

Contaminants from these sources enter the Bay system directly via municipal sewage and industrial waste outfalls, storm drains and surface runoff, aerial fallout, overboard discharge from vessels, and enter indirectly via rivers conveying agricultural drainage and materials from upland erosion to the Bay, and leaching from waste disposal sites located adjacent to the Bay and its tributaries.

POLLUTION SAMPLING

Pollution samples are obtained by the Corps of Engineers for all active maintenance dredging projects. In addition, pollution samples are taken for all proposed navigation projects during feasibility studies. For the purpose of this study, 48 additional holes were sampled at different sedimentation regimes in the Bay.

Generally, dredged channels of North San Francisco Bay have higher levels of lead, zinc, cadmium, copper and volatile solids than do channels in Central San Francisco Bay. Dredged channels of Central Bay have higher levels of mercury, oil-grease, chemical oxygen demand and total Kjeldahl nitrogen. Undredged areas of North and Central Bay on the whole have lower levels of these contaminants. Some contaminants such as zinc, mercury, oil-grease, and total Kjeldahl nitrogen can be found at higher levels outside dredged channels.

SEDIMENT-CONTAMINANT RELATIONSHIPS

Contaminant levels are generally associated with sediment type (particle size) which is reflected in both vertical and horizontal distribution of contaminants. However, this relationship is not absolute and other factors such as proximity to the source of contaminants, rate of shoaling of contaminanted sediments, rate of contaminant input, and association of contaminants to other parameters such as organics play a role in this distribution.

Size characteristics of sedimentary deposits in the Bay vary greatly both vertically with depth and spatially over area. Sediments range from a homogeneous silty clay with less than one percent sand to alternating layers of clayey silt and silty sand. Physical characteristics of sedimentary deposits reflect the environment of deposition. The environment of deposition is determined by processes mentioned previously, e.g., tide and tidal currents, water circulation and mixing characteristics, and windwave action. Where sediments are found to be uniformly distributed, the environment of deposition has necessarily been continuous throughout the history of deposition. Conversely, where the sediments exhibit a hetrongeneous distribution the environment of deposition has not been continuous. The changing environment of deposition is reflected by the vertical changes in the character of the sedimentary deposits. Furthermore, relative magnitude (energy input) of physical processes that make up the environment of deposition may be determined by size and distribution characteristics of sediments.

Thus, uniformly distributed fine sedimentary deposits indicate a continual low transportating energy environment, whereas a continuous high transporting environment would result in uniformly distributed coarse sediments.

Highest contaminant levels in San Francisco Bay are normally associated with the finest sediments. Where particle size of sediment varies widely with depth or area, contaminant levels also differ greatly. Vertical distribution of contaminants in sediments of San Francisco Bay generally reflect historical changes in the environment of deposition.

The Bay can generally be broken down into five units in regard to sediment-contaminant relationships. These areas are as follows: (1) enclosed water bodies, (2) shallow protected open water bodies, (3) shallow exposed open water bodies, (4) natural channel margins, and (5) natural channels.

The enclosed bodies of water which include most harbor complexes in San Francisco Bay are typically low energy environment areas with low velocity currents and very little windwave action. Sedimentation in these areas is moderate to high. The sediments are generally very fine and uniformly distributed with depth. Sediments contain very little sand and have high percentage of clay. Consequently, contaminant levels in sediments of these areas very high. In some areas under this category relic sand deposits may be found; however, once these coasrser, less contaminated sediments are removed by dredging, new shoaling sediments will be a fine, more contaminated material.

The shallow protected open bodies of water of San Francisco Bay are very similar in sediment and contaminant characteristics to the enclosed water bodies. These areas are located in partially protected areas where windwave action is subdued and where current velocities are very small. These areas are found along the leeshore of the Bay or along extensive subtidal flats. These are low to moderate energy environment areas and sediments are correspondingly very fine. Sediments are uniformly distributed with depth and have a very low sand content and high clay content. Average sedimentation rates in shallow protected areas are low to moderate; however, large seasonal fluctuations may occur. Contaminant levels in the shallow, protected areas are high and often exceed levels in enclosed water bodies. Contaminants are very often uniformly distributed with depth.

The shallow, exposed open bodies of water of San Francisco Bay are geographically similar to the shallow protected areas. However, these areas experience greater windwave action and stronger current velocities. Consequently, the moderate energy environment predominates and sediments are somewhat more coarse. Sedimentation rates are low to moderate. Wave action suspends the fine clays and currents transport them out of the area so that silt size sediments predominate. Contaminant levels in these sediments are fairly low and are fairly uniformly distributed with depth.

The margins of the natural channels of San Francisco Bay are the most hetrogeneous sediments found in the Bay. Sediments range from silty sand to clayey silt material with much interbedding, indicating a fluctuating moderate to high energy environment.

These channel margins have historically shown the highest rates of sedimentation in the Bay. Contaminant levels in these areas also show large vertical fluctuations.

The natural channels of San Francisco Bay have the highest transporting energy environment of the Bay. Historically these channels have shown very little sedimentation and in many cases have shown erosion. Because of the high energy environment sediments are coarse and contaminant levels are low. These channels are located in water depths of greater than 25 feet in San Francisco Bay.

TIME RELATIONSHIPS OF CONTAMINANT LEVELS

Sediments have been sampled at Corps projects beginning in 1970. The number of sampling periods since then depends on the dredging requirement of each project. For three major projects, Mare Island Strait, Richmond Harbor and Oakland Outer Harbor, which require annual

dredging, significant decreases in contaminant levels in many cases occurred over about a seven year period. The decrease may reflect the improvement of water quality in San Francisco Bay over the same period with the control of point discharges. Some increases also occurred which tend to converge with the decreases. A possible explanation is that particle size and shoaling patterns were changed due to the recent drought and the lower rate of accumulation exposed less sediment to nonpoint sources for a greater period of time.

CONCLUSION

The spatial variation of sediments in San Francisco Bay are defined by changes in levels of energy which cause erosion and transport and the history of the deposition environment. The level of contaminants is to a great extent associated with the sediment type based on the physical forces in the estuary and the contaminant sources. Finer sediments generally have higher concentrations of contaminants. Surface sediments show higher concentrations, although tracer studies show extensive mixing deeper than the top layer of sediment. The higher concentrations may be due to a greater interaction with the water column. The contaminant concentrations were also found to change significantly with time, probably due to source control.

The term "background levels" appears to have little meaning in the estuarine environment because of the spatial (horizontal and vertical) and temporal (short-term and long-term) variations within the Bay and the unknown variation of contaminants from both natural and anthropogenic sources. "Pollutional" analysis of contaminants can not be based strictly on the concentrations with bulk analysis.

No analysis is presented here on the chemical interaction of sediment, water contaminants, organics and organisms as they affect the concentration of contaminants in sediments. Other studies have not shown direct correlations between bulk analysis and water quality or organism uptake. As such the bulk analysis only represents a physical condition associated internally (chemical make-up of the sediment) and externally (natural or anthropogenic sources) with the sediment. Without knowledge of impacts, pollutional analysis must include an investigation of contaminant sources and an evaluation of the environment of sediment circulation and deposition.

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INCLOSURE 1
POLLUTANT SAMPLING

INCLOSURE 1

CORPS OF ENGINEERS POLLUTION SAMPLING
1970-1975

CORPS OF ENGINEERS POLLUTION SAMPLING
1975-1978

TABLE 1-1
INDEX TO CHEMICAL ANALYSIS OF
SAN FRANCISCO BAY SEDIMENTS

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
San Leandro Marina								
Berthing Area	1-1	2/21/72	62FA022	CofE	EPA	Grab	Surf.	V.S., COD, TKN, Hg, Pb, Zn, O-G
Entrance Ch. #1	2-1	2/1/72	63FA022	"	"	"	"	Same as 62FA022
Entrance Ch. #2	3-1	2/1/72	64FA022	"	"	"	"	" " "
Aux. Access Ch.	4-1	2/1/72	65FA022	"	"	"	"	" " "
Ramp Channel	5-1	2/1/72	66FA022	"	"	"	"	" " "

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Redwood City Harbor	6-1	4/5-6/71	2D-1/J	CofE	CofE	Suspended Sed	---	COD,TKN,N,S,SO_4,PO_4,S.S., BOD,As,Cd,Cr,Cu,CN,Pb,Hg, Ni,Zn,Coliform
			2D-1/1	"	"	Core	0-1	COD,TKN,N,S,SO_4, PO_4,As,Cd,Cr,Cu,Pb,Hg,Ni, Zn,Pest.
	7-1	4/5-6/71	2D-2/J	CofE	CofE	Suspended Sed	---	Same as 2D-1/J
			2D-2/1	"	"	Core	0-1	Same as 2D-1/1
	8-1	4/5-6/71	2D-3/J	CofE	CofE	Suspended Sed	---	Same as 2D-1/J
			2D-3/1	"	"	Core	1-2.5	Same as 2D-1/1
	9-1	4/5-6/71	2D-4/J	CofE	CofE	Suspended Sed	---	Same as 2D-1/J
			2D-4/1	"	"	Core	0-2.5	Same as 2D-1/1
			/2	"	"	"	2.5-5	" " "
	10-1	4/5-6/71	2D-5/J	CofE	CofE	Water	----	Same as 2D-1/J
			2D-5/1	"	"	Core	0-2.5	Same as 2D-1/1
			/2	"	"	"	2.5-5	" " "
	11-1	8/6/71	13395	Redwood City	Brown & Caldwell			NH_4,N,NO_3,PO_4,CN,As,Cr,Cu Pb,Zn,Cd,Hg,Ni,Grease,Pest.
	12-1	9/8/71	18FA091		EPA			V.S,TKN,COD,O-G,Hg,Pb,Zn
	13-1	9/8/71	19FA091		EPA			Same as 18FA091
	14-1	8/29/72	722612 1A		Pacific Env. Lab	Core	0.75-1.5	V.S.,TKN,COD,O-G,Hg,Pb, Zn,Cu,Cd,As,Cr,Ni,Pest.
		8/29/72	722613 1B		"	"	0-0.75	Same as 1A
	15-1	8/29/72	722614 1.5A		"	"	0.75-1.5	Same as 1A
			722615 1.5B		"	"	0-0.75	" " "
	16-1	8/29/72	722616 2A		Pacific Env. Lab	0.75 Core	1.5	Same as 1A
								" " "
		8/29/72	722617 2B		"	"		" " "
	17-1	8/29/72	722618 3A		"	"	0.75-1.5	" " "
			722619 3B		"	"	0-0.75	" " "
	18-1	8/29/72	722620 4A		"	"	0.75-1.5	" " "
			722621 4B		"	"	0-0.75	" " "
	19-1	8/29/72	722622 4.5A		"	"	0.75-1.5	" " "
			722623 4.5B		"	"	0-0.75	" " "
	20-1	8/29/72	722624 5A		"	"	0.75-1.5	" " "
			722625 5B		"	"	0-0.75	" " "

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Coyote Pt. Marina	21-1	2/2/72	Basin 1		Cook Res, Lab	Grab	Surf.	COD, O-G, V.S., Hg, Pb, Zn
	22-1	2/2/72	Basin 2		"	"	"	Same as Basin 1

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
San Bruno Channel	25-1	4/27-30/71	2D-1/J	CofE	CofE	Suspended Sed	----	COD,TKN,N,S,SO_4,PO_4,S.S. BOD,As,Cd,Cr,Cu,CN,Pb,Hg, Ni,Zn,Coliform
			2D-1/1	"	"	Core	0-2.5	COD,TKN,N,S,SO_4,PO_4, As,Cd,Cr,Cu,Pb,Hg,Ni,Zn, Pest.
			/2	"	"	"	2.5-5	Same as 2D-1/1
			/3	"	"	"	5-7.5	" " "
	26-1	4/27-30/71	2D-2/J	CofE	CofE	Suspended Sed	----	B.O.D.
			2D-2/1	"	"	Core	0-2.5	Same as 2D-1/1
			/2	"	"	"	2.5-4.2	" " "
			/3	"	"	"	5-6.3	" " "
	27-1	4/27-30/71	2D-3/J	CofE	CofE	Suspended Sed	---	Same as 2D-2/J
			2D-3/1	"	"	Core	0-2.5	Same as 2D-1/1
			/2	"	"	"	2.5-3.7	" " "
			/3	"	"	"	5-6	" " "
			/4	"	"	"	7.5-8	" " "
	28-1	4/27-30/71	2D-4/1	"	"	Core	0-2.5	Same as 2D-1/1
			/4	"	"	"	7.5-10	" " "
			/6	"	"	"	12.5-15	" " "
	29-1	4/27-30/71	2D-5/J	"	"	Suspended Sed	----	Same as 2D-1/J
			2D-5/1	"	"	Core	0-2.5	Same as 2D-1/1
			/3	"	"	"	5-7.5	" " "
			/5	"	"	"	10-12.5	" " "

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Islais Creek	30-1	5/3/71	2D-1/J	CofE	CofE	Suspended Sed	---	TKN,N,S,SO_4,PO_4,S.S.,As,Cd, COD,Cr,Cu,CN,Pb,Hg,Ni,Zn,O-G Coliform,Pest.
			2D-1/1	"	"	Core	0-2.5	COD,TKN,N,S,SO_4,PO_4, Cd,Cr,Cu,Pb,Hg,Ni,Zn
			/2	"	"	"	2.5-5	COD,TKN,S
			/3	"	"	"	5-7.5	Same as 2D-1/1
	31-1	5/3/71	2D-2/J	CofE	CofE	Suspended Sed	---	Same as 2D-1/J
			2D-2/1	"	"	Core	0-2.5	Same as 2D-1/1
			/2	"	"	"	2.5-5	Same as 2D-2/2
			/3	"	"	"	5-7	Same as 2D-2/1
	32-1	5/3/71	2D-3/J	CofE	CofE	Suspended Sed	---	Same as 2D-1/J
			2D-3/1	"	"	Core	0-2.5	Same as 2D-1/1
			/2	"	"	"	2.5-5	Same as 2D-1/2
			/3	"	"	"	5-7.5	Same as 2D-1/2
	33-1	5/3/71	2D-4/J	CofE	CofE	Suspended Sed	---	Same as 2D-1/J
			2D-4/1	"	"	Core	0-2.5	Same as 2D-1/1
			/2	"	"	"	2.5-5	" " "
	34-1	6/9/71	#1 Core		Brown & Caldwell	Core		BOD,COD,Pest.,Hg,pH,Cd,Cr,Cu, Pb,Zn,As
	35-1	6/9/71	#2 Core		"	"		Same as #1 Core
	36-1	2/15/74	2F-11 PT-1	CofE	LFE	Core	0.0-2.5	ELUTRIATE: IOD,BOD,S.S.,P, NO_3, TKN,Pest. SEDIMENT: O-G, Hg,Pb,Cd,Zn
			PT-2	"	"	"	2.5-5.0	Same as 2F-11 PT 1
			PT-3	"	"	"	5.0-7.5	" " "
			PT-4	"	"	"	7.5-10.0	" " "
	37-1	2/15/74	2F-12 PT-1	CofE	LFE	Core	0.0-2.5	Same as 2F-11 PT-1
			PT-2	"	"	"	2.5-5.0	" " "
			PT-3	"	"	"	5.0-7.5	" " "
			PT-4	"	"	"	7.5-10.0	" " "
	38-1	2/15/74	2F-13 PT-1	CofE	LFE	Core	0.0-2.5	Same as 2F-11 PT-1
			PT-2	"	"	"	2.5-5.0	" " "
			PT-3	"	"	"	5.0-7.5	" " "
			PT-4	"	"	"	7.5-10	" " "
	39-1	2/15/74	2F-14 PT-1	CofE	LEF	Core	0.0-2.5	Same as 2F-11 PT-1
			PT-2	"	"	"	2.5-5.0	" " "
			PT-3	"	"	"	5.0-7.5	" " "
			PT-4	"	"	"	7.5-10.0	" " "
	40-1	2/15/74	2F-15 PT-1	CofE	LFE	Core	0.0-2.5	Same as 2F-11 PT-1
			PT-2	"	"	"	2.5-5.0	" " "
			PT-3	"	"	"	5.0-7.5	" " "
			PT-4	"	"	"	7.5-10.0	" " "
	41-1	2/15/75	Receiving H_2O	CofE	LFE	Water	------	BOD,S.S.,P,NO_3,TKN,Pest.
	42-1	8/5/74	Receiving H_2O	CofE	RUDD	Water	------	BOD,S.S.,P,NO_3,TKN,Pest.
	43-1	8/5/74	2F-16 PT-1	CofE	RUDD	Core	0.0-2.5	Same as 2F-11 PT-1
			PT-2	"	"	"	2.5-4.0	" " "
			PT-3	"	"	"	4.0-6.5	" " "
			PT-4	"	"	"	6.5-9.0	" " "
	44-1	8/5/74	2F-17 PT-1	CofE	RUDD	Core	0.0-1.5	Same as 2F-11 PT-1
			PT-2	"	"	"	1.5-4.0	" " "
			PT-3	"	"	"	4.0-6.5	" " "
			PT-4	"	"	"	6.5-9.0	" " "
	45-1	8/5/74	2F-18 PT-1	CofE	RUDD	Core	0.0-2.5	Same as 2F-11 PT-1
			PT-2	"	"	"	2.5-4.0	" " "
			PT-3	"	"	"	4.0-6.5	" " "
			PT-4	"	"	"	6.5-9.0	" " "
			PT-5	"	"	"	9.0-11.5	" " "

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Sausalito Canal	1-2	2/2-5/71	2D-36	CofE	CofE	Suspended Sed	---	BOD,TKN,SO_4,S.S.,As,Cd,Cr,Cu, Pb,Hg,Ni,Zn,COD
			2D-36/1	"	"	Core	0-2.5	COD,TKN,N,S, SO_4,PO_4,As,Cd,Cr,Cu,Pb,Hg,Ni Zn
			/3	"	"	"	5-7.5	Same as 2D-36/1. +CN
			/5	"	"	"	10-12.5	" " "
	2-2	2/2-5/71	2D-37	CofE	CofE	Suspended Sed	---	Same as 2D-36
			2D-37/1	"	"	Core	0-2.5	Same as 2D-36/1
			/3	"	"	"	5-7.5	" " "
			/5	"	"	"	10-12.5	" " "
	3-2	2/2-5/71	2D-38	CofE	CofE	Suspended Sed	---	Same as 2D-36
			2D-38/1	"	"	Core	0-2.5	Same as 2D-36/1
			/3	"	"	"	5-7.5	" " "
			/5	"	"	"	10-12.5	" " "
	4-2	2/2-5/71	2D-39	CofE	CofE	Suspended Sed	---	Same as 2D-36 +Coliform
			2D-39/1	"	"	Core	0-2.5	Same as 2D-36/1
			/3	"	"	"	5-7.5	" " "
			/5	"	"	"	10-12.5	" " "
	5-2	2/2-5/71	2D-26	CofE	CofE	Suspended Sed	---	Same as 2D-36
			2D-26/1	"	"	Core	0-2.5	Same as 2D36/1
			/2	"	"	"	2.5-5	" " "
			/3	"	"	"	5-7.5	" " "
	6-2	2/2-5/71	2D-27	CofE	CofE	Suspended Sed	---	Same as 2D-36
			2D-27/1	"	"	Core	0-2.5	Same as 2D-36/1
			/2	"	"	"	2.5-5	" " "
			/3	"	"	"	5-7.5	" " "
	7-2	2/2-5/71	2D-28	CofE	CofE	Suspended Sed	----	Same as 2D-36
			2D-28/1	"	"	Core	0-2.5	Same as 2D-36/1
			/2	"	"	"	2.5-5	" " "
	8-2	2/2-5/71	2D-29	CofE	CofE	Suspended Sed	---	Same as 2D-36
			2D-29/1	"	"	Core	0-2.5	Same as 2D-36/1
			/2	"	"	"	2.5-5	" " "
			/3	"	"	"	5-7.5	" " "
			/4	"	"	"	7.5-10	" " "
	9-2	2/2-5/71	2D-30	CofE	CofE	Suspended Sed	---	Same as 2D-36
			2D-30/1	"	"	Core	0-2.5	Same as 2D-36/1
			/2	"	"	"	2.5-5	" " "
			/3	"	"	"	5-7.5	" " "
			/4	"	"	"	7.5-10	" " "
	10-2	2/2-5/71	2D-31	CofE	CofE	Suspended Sed	---	Same as 2D-36
			2D-31/1	"	"	Core	0-2.5	Same as 2D-36/1
			/2	"	"	"	2.5-5	" " "
			/3	"	"	"	5-7.5	" " "
			/4	"	"	"	7.5-10	" " "
	11-2	2/2-5/71	2D-32	CofE	CofE	Suspended Sed	---	Same as 2D-36
			2D-32/1	"	"	Core	0-2.5	Same as 2D-36/1
			/2	"	"	"	2.5-5	" " "
			/3	"	"	"	5-7.5	" " "
			/4	"	"	"	7.5-10	" " "
	12-2	2/2-5/71	2D-33	CofE	CofE	Suspended Sed	---	Same as 2D-36
			2D-33/1	"	"	Core	0-2.5	Same as 2D-36/1
			/2	"	"	"	2.5-5	" " "
			/4	"	"	"	7.5-10	" " "
	13-2	2/2-5/71	2D-34	CofE	CofE	Suspended Sed	---	Same as 2D-36
			2D-34/1	"	"	Core	0-2.5	Same as 2D-36/1
			/3	"	"	"	5-7.5	" " "
			/5	"	"	"	10-12.5	" " "

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Sausalito Channel (Cont'd)	14-2	2/2-5/71	2D-35	CofE	CofE	Suspended Sed	---	Same as 2D-36
			2D-35/1	"	"	Core	0.2.5	Same as 2D-36/1
			/3	"	"	"	5-7.5	" " "
			/5	"	"	"	10-12.5	" " "
	15-2	2/2-5/71	2D-40	CofE	CofE	Suspended Sed	---	Same as 2D-36
			2D-40/1	"	"	Core	0-2.5	Same as 2D-36/1
			/3	"	"	"	5-7.5	" " "
			/5	"	"	"	10-12.5	" " "
	16-2	2/2-5/71	2D-41	CofE	CofE	Suspended Sed	---	Same as 2D-36
			2D-41/1	"	"	"	0-2.5	Same as 2D-36/1
			/2	"	"	"	2.5-5	" " "
			/4	"	"	"	7.5-10	" " "
	17-2	2/2-5/71	2D-42	CofE	CofE	Suspended Sed	---	Same as 2D-36
			2D-42/1	"	"	Core	0-2.5	Same as 2D-36/1
			/2	"	"	"	2.5-5	" " "
			/3	"	"	"	5-7.5	" " "
			/4	"	"	"	7.5-10	" " "
	18-2	2/2-5/71	2D-43	CofE	CofE	Suspended Sed	---	Same as 2D-36
			2D-43/1	"	"	Core	0.2-5	Same as 2D-36/1
			/2	"	"	"	2.5-5	" " "
			/3	"	"	"	5-7.5	" " "

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
San Francisco Bar Main Ship Channel	19-2	12/28/70	-----	CofE	CofE	From Hopper	----	V.S.,COD,TKN,O-G,Hg,Pb,Zn, Ar,Cr,Cd,Cu,Ni,S,PO_4,
	20-2	4/5/71	Sta. 1	CofE	CofE	Grab	Surf.	COD,O-G,TKN,V.S.,Pb,Hg,Zn
	21-2	4/5/71	Sta. 2	"	"	"	"	Same as Sta. 1
	22-2	4/5/71	Sta. 3	"	"	"	"	" " "
	23-2	6/8/71	------	"	"	Hopper	----	COD,TKN,V.S.,Pb,Hg,Zn
	24-2	1/18/72	28FA012	CofE	EPA	Grab	Surf.	V.S.,COD,TKN,Hg,Pb,Zn,O-G
	25-2	1/18/72	29FA012	"	"	"	"	Same as 28FA012
	26-2	1/18/72	30FA012	"	"	"	"	" " "

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Alameda Naval Air Station								
Station Basin	27-2	2/24/71	PC167	CofE	CofE	Grab	Surf.	COD,TKN,V.S.,SO_4,PO_4,NO_3,Pb Hg,Zn,Cd,Cu,Cr,As,N,Ni,CN
Berthing Area	28-2	2/24/71	PC168	"	"	"	"	Same as PC167
Berthing Area	29-2	7/72	BT19 1AL1	Navy	LFE	Core	0-.5	COD,TKN,V.S.,O-G,Pb,Hg,Zn, Cd,Cu,Pest.
			BT20 1AL2	"	"	"	3-3.5	Same as 1AL1
Berthing Area	30-2	7/72	BT21 5AL1	Navy	LFE	Core	0-.5	Same as 1AL1
			BT22 5AL2	"	"	"	3-3.5	" " " No Cd,Cu
Berthing Area	31-2	7/72	BT23 6AL1	Navy	LFE	Core	0-.5	Same as 1AL1
Berthing Area	32-2	7/72	BT24 9AL1	Navy	LFE	Core	0.-5	Same as 1AL1
			BT25 9AL2	"	"	"	3-3.5	" " " No Cd,Cu
Berthing Area	33-2	7/72	BT26 10A11	Navy	LFE	Core	0-.5	Same as 1AL1
			BT27 10AL2	"	"	"	3-3.5	" " " No Cd,Cu
Turning Basin	34-2	7/72	BT28	Navy	LFE	Grab	Surf.	Same as 1AL1
Turning Basin	35-2	7/72	BT29 3AL1	Navy	LFE	Core	0-.5	Same as 1AL1
			BT30 3AL2	"	"	"	3-3.5	" " " No Cd,Cu
			BT31 3AL3	"	"	"	6-6.5	" " R No Cd,Cu
Turning Basin	36-2	7/72	BT32 8AL1	Navy	LFE	Core	0-.5	Same as 1AL1
			BT33 8AL2	"	"	"	3-3.5	" " " No Cd,Cu
Turning Basin	37-2	7/72	BT34 11AL1	Navy	LFE	Core	0-.5	Same as 1AL1
Turning Basin	38-2	7/72	BT35 12AL1	Navy	LFE	Core	0-.5	Same as 1AL1
			BT36 12AL2	"	"	"	3-3.5	" " " No Cd,Cu
Turning Basin	39-2	7/72	BT37 13AL1	Navy	LFE	Core	0-.5	COD,TKN,V.S.,O-G,Pb,Hg,Zn,Cd Cu,Pest.
Turning Basin	40-2	7/72	BT38 14AL1	Navy	LFE	Core	0-.5	Same as 13AL1
			BT39 14AL2	"	"	"	3-3.5	" " " No Cd,Cu
	41-2	7/72	Site #1	Navy	Navy	Core	0-.75	Pb,Hg,Zn,TKN,V.S.,Cd,Cu
			Site #1	"	"	"	.75-1.5	Same as Site #1
	42-2	7/72	Site #2	Navy	Navy	Core	0-.5	Same as Site #1
			Site #2	"	"	"	.5-2	" " "
			Site #2	"	"	"	2-3.5	" " "
Berthing Area	43-2	5/73	BT113 ALA1-1	Navy	LFE	Core	0-.5	COD,Pb,Hg,Zn,TKN,O-G,V.S.,Cd Cu,Pest.
			BT114 ALA1-2	"	"	"	3-3.5	COD,Pb,Hg,Zn,TKN,O-G,V.S.
			BT115 ALA1-3	"	"	"	6-6.5	Same as ALA1-2
			BT142 ALA1-4	"	"	"	9-9.5	Same as ALA1-2
			BT116 ALA1-5	"	"	"	12-12.5	" " "
Berthing Area	44-2	5/73	BT117 ALA2-1	Navy	LFE	Core	0-.5	Same as ALA1-1
			BT118 ALA2-2	"	"	"	3-3.5	Same as ALA1-2
			BT143 ALA2-3	"	"	"	6-6.5	" " "
			BT119 ALA2-4	"	"	"	9-9.5	" " "
			BT120 ALA2-5	"	"	"	12-12.5	" " "
	45-2	5/73	BT121 ALA3-1	Navy	LFE	Core	0-.5	COD,Pb,Hg,Zn,TKN,O-G,V.S.,Cd Cu,Pest.
			BT122 ALA3-2	"	"	"	3-3.5	COD,Pb,Hg,Zn,TKN,O-G,V.S.
			BT123 ALA3-3	"	"	"	6-6.5	Same as ALA3-2
			BT144 ALA3-4	"	"	"	9-9.5	" " "

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Alameda Naval Air Station (Cont'd)								
Berthing Area	46-2	5/73	BT124 ALA4-1	Navy	LFE	Core	0-.5	Same as ALA3-1
			BT145 ALA4-2	"	"	"	3-3.5	Same as ALA3-2
			BT125 ALA4-3	"	"	"	6-6.5	" " "
Turning Basin	47-2	5/73	BT126 ALA5-1	Navy	LFE	Core	0-.5	Same as ALA3-1
			BT127 ALA5-2	"	"	"	3-3.5	Same as ALA3-2
			BT146 ALA5-3	"	"	"	6-6.5	" " "
Turning Basin	48-2	5/73	BT128 ALA6-2	Navy	LFE	Core	0-.5	Same as ALA3-1
			BT129 ALA6-3	"	"	"	3-3.5	Same as ALA3-2
			BT147 ALA6-4	"	"	"	6-6.5	" " "
			BT130 ALA6-5	"	"	"	9-9.5	" " "
Turning Basin	49-2	5/73	BT131 ALA7-1	Navy	LFE	Core	0-.5	COD,Pb,Hg,Zn,TKN,O-G, V.S.,Cd,Cu,Pest.
			BT132 ALA7-2	"	"	"	3-3.5	COD,Pb,Hg,Zn,TKN,O-G, V.S.
			BT148 ALA7-3	"	"	"	6-6.5	Same as ALA7-2
			BT133 ALA7-4	"	"	"	9-9.5	" " "
Ship Channel	50-2	5/73	BT134 ALA8-1	Navy	LFE	Core	0-.5	Same as ALA7-1
			BT135 ALA8-2	"	"	"	3-3.5	Same as ALA7-2
			BT136 ALA8-3	"	"	"	6-6.5	" " "
			BT149 ALA8-4	"	"	"	9-9.5	" " "
Ship Channel	51-2	5/73	BT137 ALA9-1	Navy	LFE	Core	0-.5	Same as ALA7-1
			BT138 ALA9-2	"	"	"	3-3.5	Same as ALA7-2
			BT150 ALA9-3	"	"	"	6-6.5	" " "
Ship Channel	52-2	5/73	BT139 ALA10-1	Navy	LFE	Core	0-.5	Same as ALA7-1
			BT140 ALA10-2	"	"	"	3-3.5	Same as ALA7-2
			BT151 ALA10-3	"	"	"	6-6.5	" " "
			BT141 ALA10-4	"	"	"	9-9.5	" " "
NAS ALAMEDA	153-2	8/5/74	2D-1PT 1	CofE	Rudd Lab	Core	0-2.5	Elutirate: IOD,BOD,P,NO_3,TKN, Pest.
			PT 2					Sediment: O-G,Hg,Cd,Pb,Zn
			PT 2	"	"	"	2.5-5.0	Same as 2D-1 PT 1
			PT 3	"	"	"	5.0-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
	154-2	8/5/74	2D-2PT 1	CofE	Rudd	Core	0.0-2.5	Same as 2D-1 PT 1
			PT 2	"	"	"	2.5-5.0	" " "
	155-2	8/5/74	2D-9PT 1	CofE	Rudd	"	0.0-2.5	Same as 2D-1 PT 1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5.0-7.5	" " "

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
NAS Alameda (Cont'd)								
	156-2	8/5/74	2D-8 PT-1	CofE	Rudd	Core	0.0-2.5	Same as 2D-1 PT-1
	157-2	8/5/74	2D-7 PT-1	CofE	"	"	0.0-2.5	Same as 2D-1 PT-1
			PT-2	"	"	"	2.5-5.0	" " "
	158-2	8/5/74	2D-6 PT-1	CofE	Rudd	Core	0.0-2.5	Same as 2D-1 PT-1
			PT-2	"	"	"	2.5-5.0	" " "
	159-2	8/5/74	2D-5 PT-1	CofE	Rudd	Core	0.0-2.5	Same as 2D-1 PT-1
			PT-2	"	"	"	2.5-5.0	" " "
	160-2	8/5/74	2D-3 PT-1	CofE	Rudd	Core	0-2.5	" " "
	161-2	8/5/74	2D-4 PT-1	"	"	"	0-2.5	" " "
	162-2	8/5/74	Receiving Water	"	"	"	------	BOD,P,NO_3,TKN,Pest.
	163-2	9/23/74	2D-1A PT-1	CofE	Rudd	Core	0.0-2.5	Sediment only Hg,Pb,Zn,Cd
			PT-2	"	"	"	2.5-5.0	" " "
			PT-3	"	"	"	5.0-7.5	" " "
			PT-4	"	"	"	7.5-10.0	" " "
	164-2	8/23/74	2D-2A	CofE	Rudd	Core	0.0-2.5	Same as 2D-1A PT-1
			PT-2	"	"	"	2.5-5.0	" " "
			PT-3	"	"	"	5.0-7.5	" " "
	165-2	9/23/74	2D-9A PT-1	CofE	Rudd	Core	0.0-2.5	Same as 2D-1A PT-1
			PT-2	"	"	"	2.5-5.0	" " "
			PT-3	"	"	"	5.0-7.5	" " "

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Richmond Harbor	53-2	8/10/71	121FA081	CofE	EPA	Grab	Surf.	V.S.,COD,TKN,Hg,Pb,Zn,O-G, Mn
	54-2		122FA081	"	"	"	"	Same as 121FA081
	55-2		123FA081	"	"	"	"	" " "
	56-2	5/26/72	2173 1A	Port of Richmond	Port of Richmond	Core	0-2.5	V.S.,COD,TKN,O-G, Hg,Pb,Zn,Pest.
			2174 1A	"	"	"	2.5-5	Same as 2173
			2175 1A	"	"	"	5-7.5	" " "
			2176 1A	"	"	"	8-10.5	" " "
			2177 1A	"	"	"	13.5-15.5	" " "
			2178 1A	"	"	"	15.5-18.5	" " "
			2179 1A	"	"	"	21-23.5	" " "
			2180 1A	"	"	"	23.5-26	" " "
	57-2	5/22/74	2078 11A	Port of Richmond	Port of Richmond	Core	0-2.5	Same as 2173
			2079 11A	"	"	"	5-6.3	" " "
			2080 11A	"	"	"	10-11.5	" " "
			2081 11A	"	"	"	15-16.3	" " "
			2082 11A	"	"	"	20-21.5	" " "
			2083 11A	"	"	"	25-26.3	" " "
			2084 11A	"	"	"	32.5-34.5	" " "
			2085 11A	"	"	"	37.5-39	" " "
	58-2	5/19/72	2070 X	Port of Richmond	Port of Richmond	Core	0-2.5	Same as 2173
			2073 X	"	"	"	11.5-14	" " "
			2074 X	"	"	"	23.5-25.5	" " "
	59-2	5/23/74	2086 X11	Port of Richmond	Port of Richmond	Core	0-2.5	Same as 2173
			2087 X11	"	"	"	22.5-25	" " "
			2088 X11	"	"	"	41-41.5	" " "
	60-2	7/21/71	2D-13 PT 1-12	CofE	EPA	Core		V.S.,COD,TKN,Hg,Pb,Zn,O-G,Mn
	61-2	7/21/71	2D-12 PT 1-16	"	"	"		Same as 2D-13
	62-2	7/21/71	2D-11 PT 1-3	"	"	"		Same as 2D-13
	63-2	8/14/72	15601 Sta. 1	Stand. Oil	Envir. Qual. Anal.	Core	0-.5	V.S.,COD,TKN,G,Hg,Bp,Zn,Cu,Cd
			15602 "	"	"	"	1-4	Same as 15601
	64-2	8/14/72	15603 Sta. 2	"	"	"	0-1	Same as 15601
	65-2	8/14/72	15604 Sta. 3	"	"	"	0-.5	Same as 15601
			15605 "	"	"	"	3-6	" " "
			15606 "	"	"	"	8.5-10.5	" " "
	66-2	8/14/72	15607 Sta. 4	"	"	"	0-.5	Same as 15601
			15608 "	"	"	"	4-6	" " "
	67-2	8/14/72	15609 Sta. 5	"	"	"	0-.5	Same as 15601
			15610 "	"	"	"	8.5-11.5	" " "
			15611 "	"	"	"	10.75-14	" " "
	68-2	8/14/72	15612 Sta. 6	"	"	"	0-.5	" " "
			15613 "	"	"	"	2-6	" " "
	69-2	9/12/72	722835 1	City of Richmond	Pacific Envir. Lab	Core	0-5	V.S.,COD,TKN,O-G,Hg,Pb,Zn, Cu,Cd,Pest.
			722836 "	"	"	"	.5-2	Same as 722835
			722837 "	"	"	"	2-3.5	" " "
	70-2	9/25/72	2D-1 B	CofE	CofE	Core	0-.75	V.S.,COD,TKN,O-G,Hg, Pb,Zn,Cu,Cd,Pest.,As,Ni,Cr
			A	"	"	"	.75-1.5	Same as 2D-1 B

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Richmond Harbor (Cont'd)	71-2	9/25/72	2D-2 B	CofE	CofE	Core	0-.75	Same as 2D-1 B
			A	"	"	"	.75-1	" " "
	72-2	9/25/72	2D-3 B	CofE	CofE	Core	0-.75	Same as 2D-1 B
			A	"	"	"	.75-1	" " "
	73-2	9/25/72	2D-4 B	CofE	CofE	Core	0.-75	Same as 2D-1 B
			A	"	"	"	.75-1	" " "
	74-2	9/25/72	2D-5 B	CofE	CofE	Core	0-.75	Same as 2D-1 B
			A	"	"	"	.75-11	" " "
	75-2	9/25/72	2D-6 B	CofE	CofE	Core	0-.75	Same as 2D-1 B
			A	"	"	"	.75-1	" " "
	166-2	6/74	PC 1340 Disposal Site Water	CofE	CofE	Water	-----	D.O., BOD, S.S., P, NO_3, TKN, Pest.
	167-2	6/74	2D-94 PT 1	CofE	CofE	Core	0.0-2.5	Elutriate: IOD, BOD, S.S., P, NO_3, TKN, Pest., Sediment: O-G, Hg, Cd, Pb, Zn, Cu
			PT 2	CofE	"	"	2.5-5.0	Same as 2D-94 PT-1
			PT 3	"	"	"	5.0-7.5	" " "
	168-2	6/74	2D-95 PT 1	CofE	CofE	Core	0.0-2.5	Same as 2D-94 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3&4	"	"	"	5.0-10.0	" " "
			PT 5&6	"	"	"	10.0-15.0	" " "
			PT 7&8	"	"	"	15.0-19.8	" " "
			PT 9&10	"	"	"	20.0-24.0	" " "
			PT 11&12	"	"	"	25.0-29.2	" " "
	169-2	6/74	2D-96 PT 1	CofE	CofE	Core	0.0-1.0	Same as 2D-94 PT-1
			PT 2&3	"	"	"	2.5-7.5	" " "
			PT 4&5	"	"	"	7.5-12.5	" " "
	170-2	6/74	2D-97 PT 1	CofE	CofE	Core	0.0-2.5	Same as 2D-94 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
	171-2	6/74	2D-98 PT 1	CofE	CofE	Core	0.0-2.5	Same as 2D-94 PT-1
			PT 2&3	"	"	"	2.5-6.6	" " "
			PT 4&5	"	"	"	7.5-12.5	" " "
	172-2	6/74	2D-99 PT 1	CofE	CofE	Core	0.0-1.5	Same as 2D-94 PT-1
			PT 2	"	"	"	2.5-3.8	" " "
			PT 3	"	"	"	5.0-7.3	" " "
			PT 4	"	"	"	7.5-10.0	" " "
	173-2	6/74	2D-100 PT 1	CofE	CofE	Core	0.0-2.5	Same as 2D-94 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5.0-7.5	" " "
			2D-100A PT 4	"	"	"	7.5-8.9	Same as 2D-94 PT-1
	174-2	6/74	2D-101 PT 1	CofE	CofE	Core	0.0-2.5	Same as 2D-94 PT-1
			PT 2&3	"	"	"	2.5-7.5	" " "
			PT 4&5	"	"	"	7.5-12.1	" " "
	175-2	6/74	2D-102 PT 1	CofE	CofE	Core	0.0-2.5	Same as 2D-94 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3&4	"	"	"	5.0-9.7	" " "
	176-2	6/74	2D-103 PT 1	CofE	CofE	Core	0.0-2.5	Same as 2D-94 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5.0-7.5	" " "
	177-2	6/74	2D-104 PT 1	CofE	CofE	Core	0.0-2.5	Same as 2D-94 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5.0-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
			PT 5	"	"	"	10.0-12.5	" " "
	178-2	6/74	2D-105 PT 1	CofE	CofE	Core	0.0-2.5	Same as 2D-94 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5.0-7.5	" " "
	179-2	6/74	2D-106 PT 1	CofE	CofE	Core	0.0-2.5	Same as 2D-94 PT-1
			PT 2&3	"	"	"	2.5-6.4	" " "
			PT 4&5	"	"	"	6.4-10.4	" " "

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Richmond Harbor (Cont'd)	180-2	6/74	2D-107 PT 1	CofE	CofE	Core	0.0-2.5	Same as 2D-94 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3&4	"	"	"	5.0-10.0	" " "
	181-2	6/74	2D-108 PT 1	CofE	CofE	Core	0.0-2.5	Same as 2D-94 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3&4	"	"	"	5.0-10.0	" " "
			PT 5&6	"	"	"	10.0-15.0	" " "
	182-2	6/74	2D-109 PT 1	CofE	CofE	Core	0.0-2.5	Same as 2D-94 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3&4	"	"	"	5.0-10.0	" " "
			PT 5&6	"	"	"	10.0-15.0	" " "
	183-2	6/74	2D-110 PT 1	CofE	CofE	Core	0.0-2.5	Same as 2D-94 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5.0-7.5	" " "
			PT 4&5	"	"	"	7.5-12.5	" " "
	184-2	7/10/74	2D-124 PT 1	CofE	PEL	Core	0-2.5	Elutriate: D.O.,BOD,S.S., P,N,TKN,Pest. Sediment: O-G,Hg,Cd, Pb,Zn
		8/74	2D-124 PT 2	CofE	CofE	Core	2.5-4.0	Elutriate: Same as 2D-124 PT-1 w/o D.O.,Pest. Sediment: O-G,Hg,Cd, Pb,Zn,Cu
	185-2	7/10/74	2D-123 PT 1	CofE	PEL	Core	0-2.5	Same as 2D-124 PT-1
		8/74	PT 2	"	"	"	2.5-5.0	Same as 2D-124 PT-2
			PT 3	"	"	"	5.0-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
	186-2	7/10/74	2D-122 PT 1	CofE	PEL	Core	0-1.5	Same as 2D-124 PT-1
		8/74	PT 2	"	CofE	"	1.5-2.0	Same as 2D-124 PT-1
			PT 3	"	"	"	------	Elutriate: IOD, only
			PT 4	"	"	"	------	Elutriate: " "
	187-2	7/10/74	2D-117 PT 1	CofE	PEL	Core	0-1.5	Same as 2D-124 PT-1
		8/74	PT 2	"	CofE	"	1.5-4.0	Same as 2D-124 PT-2
			PT 3	"	"	"	4.0-6.0	" " "
			PT 4	"	"	"	6.5-8.2	" " "
			PT 5	"	"	"	9.0-10.9	" " "
	188-2	7/10/74	2D-118 PT 1	CofE	PEL	Core	0-2.5	Same as 2D-124 PT-1
		8/74	PT 2	"	CofE	"	2.5-4.5	Same as 2D-124 PT-2
			PT 3	"	"	"	5.0-7.2	" " "
			PT 4	"	"	"	7.5-10.0	" " "
			PT 5	"	"	"	10.0-12.0	" " "
	189-2	7/10/74	2D-119 PT 1	CofE	PEL	Core	0-2.5	Same as 2D-124 PT-1
		8/74	PT 2	"	CofE	"	2.5-4.7	Same as 2D-124 PT-2
			PT 3	"	"	"	5.0-7.0	" " "
			PT 4	"	"	"	7.5-10.0	" " "
			PT 5	"	"	"	10.0-12.5	" " "
			PT 6	"	"	"	12.5-15.0	" " "
	190-2	8/74	2D-120 PT 1	CofE	CofE	Core	0-2.5	Elutriate: IOD,BOD, S.S.,P,NO_3 ,TKN Sediment: O-G,Hg,Pb, Zn,Cd,Cu
			PT 2	"	"	Core	2.5-5.0	Same as 2D-120 PT-1
			PT 3	"	"	"	5.0-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
			PT 5	"	"	"	10.0-12.5	" " "
			PT 6	"	"	"	12.5-15.0	" " "
			PT 7	"	"	"	15.0-17.5	" " "
			PT 8	"	"	"	17.5-20.0	" " "
	191-2	7/10/74	2D-121 PT 1	CofE	PEL	Core	0.0-2.0	Elutriate: D.O.,BOD,S.S., P,NO_3,TKN,Pest Sediment: O-G,Hg,Cd,Pb,Zn
		8/74	PT 2	"	CofE	"	2.0-4.0	Same as 2D-120 PT-1
			PT 3	"	"	"	4.0-6.5	" " "
			PT 4	"	"	"	6.5-8.7	" " "
			PT 5	"	"	"	9.0-11.5	" " "

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Richmond Harbor (Cont'd)	192-2	7/10/74	2D-113 PT 1	CofE	PEL	Core	0-2.5	Same as 2D-121 PT-1
		8/74	PT 2	"	CofE	"	2.5-5.0	Same as 2D-120 PT-1
			PT 3	"	"	"	5.0-7.5	" " "
	193-2	7/10/74	2D-112 PT 1	CofE	PEL	Core	0-2.5	Same as 2D-121 PT-1
		8/74	PT 2	"	CofE	"	2.5-5.0	Same as 2D-120 PT-1
			PT 3	"	"	"	5.0-7.5	" " "
	194-2	7/10/74	2D-111 PT-1	CofE	PEL	Core	0-2.5	Same as 2D-121 PT-1
		8/74	PT 2	"	"	"	2.5-5.0	Same as 2D-120 PT-1
			PT 3	"	"	"	5-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
	195-2	8/74	2D-114 PT 1	CofE	CofE	Core	0-1.0	Elutriate: IOD,BOD, S.S.,P,NO_3,TKN Sediment: O-G,Hg,Cd Pb,Zn,Cu
			PT 2	"	"	"	1-3.5	Same as 2D-114 PT-1
			PT 3	"	"	"	3.5-6.0	" " "
			PT 4	"	"	"	6.0-8.5	" " "
	196-2	8/74	2D-115 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-114 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
	197-2	8/74	2D-116 PT 1	CofE	CofE	Core	0-1.0	Same as 2D-114 PT-1
			PT 2	"	"	"	1-2.3	" " "
			PT 3	"	"	"	2.5-5.0	" " "
			PT 4	"	"	"	5.0-6.5	" " "
			PT 5	"	"	"	6.5-8.8	" " "
			PT 6	"	"	"	9.0-11.0	" " "
			PT 7	"	"	"	11-13.5	" " "
			PT 8	"	"	"	13.5-16.0	" " "
			PT 9	"	"	"	16-18.5	" " "
	198-2	7/10/74	741642	CofE	PEL	Water		BOD,S.S,P,NO_3, TKN,Pest.
	199-2	8/74	PC 1547	CofE	CofE	Water		BOD,S.S,P,NO_3,TKN, O-G,Hg,Cd,Pb,Zn,Cu

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Point Molate	77-2	2/24/71	Sta.C	CofE	CofE	Grab & Water	Surf.	Coliform,BOD, TKN,NO_3,N,S,SO_4,PO_4,As, Cd,Cr,Cu,CN,Pb,Hg,Ni Pest.
	78-2	8/30/72	BT42 1-1	Navy	LFE	Core	0-.5	COD,Cd,Cu,Pb,Hg,TKN,O-G, V.S.,Zn,Pest.
			BT43 1-2	"	"	"	3-3.5	COD,Pb,Hg,TKN,O-G,V.S.,Zn
	79-2	8/30/72	BT44 2-1	Navy	LFE	Core	0-.5	Same as BT42
	80-2	8/30/72	BT45 3-1	Navy	LFE	Core	0-.5	Same as BT42
	81-2	8/30/72	BT46 4-1	Navy	LFE	Core	0-.5	Same as BT42
	82-2	8/30/72	BT47 5-1	Navy	LFE	Core	0-.5	Same as BT42
	83-2	8/30/72	BT48 6-1	Navy	LFE	Core	0-.5	Same as BT42
			BT49 6-2	"	"	"	3-3.5	Same as BT43
	84-2	8/30/72	BT50 7-1	Navy	LFE	Core	0-.5	Same as BT42
	85-2	8/30/72	BT51 8-1	Navy	LFE	Core	0-.5	Same as BT42
	86-2	8/30/72	BT52 8A	Navy	LFE	Grab	Surf.	Same as BT42
	200-2	8/5/74	2D-1 PT 1	CofE	Rudd	Core	0.0-2.5	Elutriate: IOD,BOD,P,NO_3, TKN,Pest. Sediment: O-G,Hg,Cd,Pb,Zn
			PT 2	"	"	"	2.5-5.0	Same as 2D-1 PT-1
			PT 3	"	"	"	5.0-7.5	" " "
	201-2	8/5/74	2D-2 PT 1	CofE	Rudd	Core	0.0-2.5	Same as 2D-1 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5.0-7.5	" " "
	202-2	8/5/74	2D-3 PT 1	CofE	Rudd	Core	0.0-2.5	Same as 2D-1 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5.0-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
	203-2	8/5/74	2D-4 PT 1	CofE	Rudd	Core	0.0-2.5	Same as 2D-1 PT 1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5.0-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
			PT 5	"	"	"	10.0-12.5	" " "
	204-2	8/5/74	2D-5 PT 1	CofE	Rudd	Core	0.0-2.5	Same as 2D-1 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5.0-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
	205-2	8/5/74	2D-6 PT 1	CofE	Rudd	Core	0.0-2.5	Same as 2D-1 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5.0-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
			PT 5	"	"	"	10.0-12.5	" " "
			PT 6	"	"	"	12.5-15.0	" " "
			PT 7	"	"	"	15.0-17.5	" " "
	206-2	8/5/74	2D-7 PT 1	CofE	Rudd	Core	0.0-2.5	Same as 2D-1 PT 1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5.0-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
San Pablo Bay Pt. Davis	1-3	8/31/72	15779 Sta. 1	Union	Envir. Qual Anal.	Core	0-.5	V.S.,COD,Grease,Hg,Pb,Zn, S.S.
			15780 Sta. 1	"	" "	"	0.25-1.25	Same as 15779
	2-3	8/31/72	15781 Sta. 2	Union	Envir. Qual Anal.	Core	0-.5	Same as 15779
			15782 Sta. 2	"	" "	"	1-2.75	" " "
	3-3	8/31/72	15783 Sta. 3	Union	Envir. Qual Anal.	Core	0-.5	Same as 15779
			15784 Sta. 3	"	" "	"	.5-2.0	" " "
			15785 Sta. 3	"	" "	"	2-3.5	" " "

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
San Francisco Bay	87-2	4/16/73	2D-32 PT 1	CofE	CofE	Core	0-2.4	V.S., COD, TKN, O-G, Hg, Pb, Zn
			PT 2&3	"	"	"	2.4-7.5	Same as 2D-32 PT-1
			PT 4-6	"	"	"	7.5-17.5	" " "
			PT 7-9	"	"	"	17.5-22.5	" " "
			PT 10-12	"	"	"	22.5-30.0	" " "
			PT 13&14	"	"	"	30-35.0	" " "
	88-2	4/19/73	2D-33 PT 1	CofE	CofE	Core	0-2.4	Same as 2D-32 PT-1
			PT 2-4	"	"	"	2.4-9.0	" " "
			PT 5-7	"	"	"	9-17.5	" " "
			PT 8-10	"	"	"	17.5-25.0	" " "
			PT 11-13	"	"	"	25-32.5	" " "
			PT 14&15	"	"	"	32.5-37.5	" " "
	89-2	4/23/72	2D-34 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-32 PT 1
			PT 2&3	"	"	"	2.5-7.5	" " "
			PT 4&5	"	"	"	7.5-12.5	" " "
	90-2	4/23/73	2D-35 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-32 PT 1
			PT 2&3	"	"	"	2.5-7.5	" " "
			PT 4&5	"	"	"	7.5-10	" " "
			PT 6	"	"	"	10-12.5	" " "
	91-2	4/25/73	2D-36 PT 1&2	CofE	CofE	Core	0-2.0	Same as 2D-32 PT-1
			PT 3&4	"	"	"	2-10.0	" " "
			PT 5	"	"	"	10-17.5	" " "
	92-2	4/25/73	2D-37 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-32 PT-1
			PT 2&3	"	"	"	2.5-7.5	" " "
			PT 4&5	"	"	"	7.5-12.5	" " "
	93-2	4/25/73	2D-38 PT 1&2	CofE	CofE	Core	0-5.0	V.S., COD, TKN, O-G, Hg, Pb, Zn
			PT 3&4	"	"	"	5-10.0	Same as 2D-38 PT 1&2
			PT 5&6	"	"	"	10-15.0	" " "
	94-2	4/27/73	2D-41 PT 1&2	CofE	CofE	Core	0-5.0	Same as 2D-38 PT 1&2
			PT 3&4	"	"	"	5-10.0	" " "
			PT 5	"	"	"	10-12.5	" " "
	95-2	5/1/73	2D-42 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-38 PT 1&2
			PT 2&3	"	"	"	2.5-7.5	" " "
			PT 4&5	"	"	"	7.5-12.5	" " "
	96-2	5/1/73	2D-43 PT 1&2	CofE	CofE	Core	0-5.0	Same as 2D-38 PT 1&2
			PT 3&4	"	"	"	5-10.0	" " "
			PT 5	"	"	"	10-12.5	" " "
	97-2	5/2/73	2D-44 PT 1&2	CofE	CofE	Core	0-5.0	Same as 2D-38 PT 1&2
			PT 2&3	"	"	"	5-10.0	" " "
	98-2	5/3/73	2D-46 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-38 PT 1&2
			PT 3	"	"	"	2.5-5.0	" " "
	99-2	5/8/73	2D-48 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-38 PT 1&2
			PT 2&3	"	"	"	2.5-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
	100-2	5/9/73	2D-49 PT 1	CofE	CofE	Core	0-2.5	V.S., COD, TKN, O-G, Hg, Pb, Zn
			PT 2&3	"	"	"	2.5-7.5	Same as 2D-49 PT 1
	101-2	5/10/73	2D-50 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-49 PT 1
			PT 2&3	"	"	"	2.5-7.5	" " "
	102-2	5/10/73	2D-51 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-49 PT 1
			PT 2&3	"	"	"	2.5-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Oakland Outer Harbor								
	103-2	5/10/73	10FA091	CofE	EPA	Core	0-2.5	COD,V.S.,TKN,Hg,Pb,Zn,O-G
	104-2	10/26/71	11FA091	CofE	EPA	Core	0-2.5	Same as 10FA091
	105-2	11/29/71	712003	PofOak	PEL	"	0-2.5	V.S.,COD,TKN,O-G,Hg,Pb,Zn
	106-2	11/29/71	712004	PofOak	PEL	Core	0-2.5	Same as 712003
	107-2	11/29/71	712005	"	"	"	0-2.5	" " "
	108-2	11/29/71	712006	"	"	"	0-2.5	" " "
	109-2	11/29/71	712007	"	"	"	0-2.5	" " "
	110-2	11/29/71	712008	"	"	"	0-2.5	" " "
	111-2	11/29/71	712009	"	"	"	0-2.5	" " "
	112-2	11/29/71	712010	"	"	"	0-2.5	" " "
	113-2	11/72	2D-1 PT 1	CofE	CofE	Core	.75-1.5	V.S.,COD,TKN,O-G, Hg,Pb,Zn,Cd,Cu,Cr,As
			PT 2	"	"	"	0-.75	Same as 2D-1 PT-1
	114-2	11/72	2D-2 PT 1	CofE	CofE	Core	.75-1.5	Same as 2D-1 PT-1
			PT 2	"	"	"	0-.75	" " "
	115-2	11/72	2D-3 PT 1	CofE	CofE	Core	.75-1.5	Same as 2D-1 PT-1
			PT 2	"	"	"	0-.75	" " "
	116-2	11/72	2D-4 PT 1	CofE	CofE	Core	.75-1.5	Same as 2D-1 PT-1
			PT 2	"	"	"	0-.75	" " "
	117-2	11/72	2D-5 PT 1	CofE	CofE	Core	.75-1.5	Same as 2D-1 PT-1
			PT 2	"	"	"	0-.75	" " "
	118-2	11/72	2D-6 PT 1	CofE	CofE	Core	.75-1.5	Same as 2D-1 PT-1
			PT 2	"	"	"	0-.75	" " "
	119-2	2/18/72	1A (1)	URS	URS	Core	.5-1.5	V.S.,COD,TKN,O-G,Hg Pb,Zn,Cu,Cd
			1A (2)	"	"	"	3-3.6	Same as 1A (1)
			1B	"	"	"	4.5-5.4	" " "
	120-2	2/18/72	2A (1)	URS	URS	Core	3-3.6	Same as 1A (1)
			2A (2)	"	"	"	6.6-7.0	" " "
			3A	"	"	"	2.2-2.6	" " "
	121-2	10/73	PC850	CofE	CofE	Water	------	Alcatraz-DO,BOD, S.S., TKN, NO_3,P,SO_4,Pb,Cu,Hg, Cd,O-G
	122-2	10/73	2D-134	CofE	CofE	Core	0-2.5	Elutriate-IOD, V.S., S.S.,TKN,NO_3,P,SO_4, Pb,Cu,Hg,Cd,O-G
	123-2	10/73	2D-135 PT 1	CofE	CofE	Core	0-2.5	Elutriate-IOD, V.S., S.S.
	124-2	10/73	2D-136 PT 1	CofE	CofE	Core	0-2.5	Elutriate-Same as 2D-134 PT-1
	125-2	10/73	2D-137 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-134 PT-1
	126-2	10/73	2D-138 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-134 PT-1
	127-2	10/73	2D-139 PT-1	CofE	CofE	Core	0-2.5	Same as 2D-134 PT-1
	207-2	8/16/74		CofE	Rudd	Water(Disposal Site)		BOD,P,NO_3,TKN,Pest
	208-2	9/74	PC 1565	CofE	CofE	Water(Disposal Site)		" " "
	209-2	8/16/74	2D-140 PT 1	CofE	Rudd	Core	0-1.5	Elutriate: IOD,BOD,P,NO_3, TKN,S.S.,Pest. Sediment: O-G,Hg,Pb,Zn,Cd
			PT 2	"	"	"	1.5-3.5	Same as 2D-140 PT-1
		8/74	PT 3&4	"	CofE	"	4.0-7.0	Same as 2D-140 PT-1 + Cu
			PT 5&6	"	"	"	7.0-10.0	" " "
			PT 7&8	"	"	"	10.0-13.0	" " "
	210-2	8/16/74	2D-141 PT 1&2	CofE	Rudd	Core	0.0-3.0	Same as 2D-140 PT-1
		9/74	PT 3&4	"	CofE	"	8.0-6.0	Same as 2D-140 PT-1 + Cu
			PT 5&6	"	"	"	6.0-9.0	" " "
			PT 7&8	"	"	"	9.0-12.0	" " "

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Oakland Outer Harbor (Cont'd)								
	211-2	8/16/74	2D-142 PT-1	CofE	Rudd	Core	0.0-1.5	Same as 2D-140 PT-1
			PT-2	"	"	"	1.5-3.3	" " "
			PT 3	"	"	"	3.3-4.6	" " "
			PT 4	"	"	"	4.6-7.1	" " "
			PT 5	"	"	"	7.1-8.6	" " "
	212-2	8/16/74	2D-143 PT 1	CofE	Rudd	Core	0.0-2.5	Same as 2D-140 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5.0-7.5	" " "
	213-2	8/16/..	2D-144 PT 1	CofE	Rudd	Core	0.0-2.5	Same as 2D-140 PT-1
		9/74	PT 2&3	"	CofE	"	2.5-5.5	Same as 2D-140 PT-1+Cu
			PT 4&5	"	"	"	5.5-8.5	" " "
	214-2	8/16/74	2D-145 PT 1	CofE	Rudd	Core	0.0-2.3	Same as 2D-140 PT-1
		9/74	PT 2&3	"	"	"	2.5-5.4	Same as 2D-140 PT-1+Cu
			PT 4&5	"	"	"	5.4-8.5	" " "
			PT 6&7	"	"	"	8.5-11.2	" " "
	215-2	8/16/74	2D-146 PT 1	CofE	Rudd	Core	0.0-2.3	Same as 2D-140 PT-1
			PT 2	"	"	"	2.5-4.5	" " "
		9/74	PT 3&4	"	CofE	"	5.0-8.0	" " "
			PT 5&6	"	"	"	8.0-11.0	" " "
			PT 7&8	"	"	"	11.0-14.0	" " "
	216-2	8/16/74	2D-147 PT 1	CofE	Rudd	Core	0.0-2.3	Same as 2D-140 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5.0-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
			PT 5	"	"	"	10.0-12.1	" " "
	217-2	8/16/74	2D-148 PT 1	CofE	Rudd	Core	0.0-2.5	Same as 2D-140 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5.0-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
			PT 5	"	"	"	10.0-12.1	" " "
	218-2	8/16/74	2D-149 PT 1	CofE	Rudd	Core	0.0-1.5	Same as 2D-140 PT-1
		9/74	PT 2&3	"	CofE	"	1.5-5.5	Same as 2D-140 PT-1+Cu
			PT 4&5	"	"	"	5.5-7.5	" " "
			PT 6&7	"	"	"	7.5-10.5	" " "

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Oakland Inner Harbor								
	128-2	3/11/71	2D-14 PT 1	CofE	EPA	Core	0-.5	V.S.,COD,Hg,Pb,Zn
			PT 2	"	"	"	.5-1.0	Same as 2D-14 PT 1
			PT 3	"	"	"	1-1.5	" " "
	129-2	3/11/71	2D-15 PT 1	CofE	EPA	Core	0-.5	Same as 2D-14 PT 1
			PT 2	"	"	"	.5-1.0	" " "
	130-2	3/11/71	2D-16 PT 1	CofE	EPA	Core	0-.5	Same as 2D-14 PT 1
	131-2	3/11/71	2D-17 PT 1	CofE	EPA	Core	0-.5	Same as 2D-14 PT 1
			PT 2	"	"	"	.5-1.0	" " "
	132-2	3/11/71	2D-18 PT 1	CofE	EPA	Core	0-.5	Same as 2D-14 PT 1
			PT 2	"	"	"	.5-1.0	" " "
			PT 3	"	"	"	1-1.5	" " "
	133-2	3/11/71	2D-24 PT 1	CofE	EPA	Core	0-.5	Same as 2D-14 PT 1
			PT 2	"	"	"	.5-1.0	" " "
	134-2	3/11/71	2D-25 PT 1	CofE	EPA	Core	0-.5	Same as 2D-14 PT 1
	135-2	3/11/71	2D-26 PT 1	CofE	CofE	Core	0-.5	Same as 2D-14 PT 1
			PT 2	"	"	"	.5-1.0	Same as 2D-14 PT 1
			PT 3	"	"	"	1-1.5	" " "
	136-2	9/73	2D-96 PT 1	CofE	CofE	Core	0-2.5	V.S.,COD,TKN,O-G Hg,Pb,Zn
			PT 2	"	"	"	2.5-5.0	Same as 2D-96 PT 1
	137-2	9/73	2D-97 PT 1	CofE	CofE	Core	0-2.5	V.S.,COD,TKN,O-G, Hg,Pb,Zn
			PT 2	"	"	"	2.5-5.0	Same as 2D-97 PT 1
	138-2	10/73	PC848	CofE	CofE	Water	------	Alcatraz-DO,BOD, S.S., TKN,Hg,NO_3,P,O-G,SO_4,Pb, Cu,Cd
	139-2	10/73	2D-13 PT 1	CofE	CofE	Core	0-2.5	Elutriate & Sediment - IOD, V.S., TKN,NO_3,P, O-G,SO_4,Pb,Cu,Cd
	140-2	10/73	2D-14 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-13 PT 1
	141-2	10/73	2D-15 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-13 PT 1
	142-2	10/73	2D-17 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-13 PT 1
	143-2	10/73	2D-21 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-13 PT 1
	144-2	10/73	2D-25 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-13 PT 1
	145-2	2/9/74	Hole A (1) 2D-182	CofE	LFE	Core		Elutriate-IOD,BOD,S.S.,P, NO_3,TKN,Pest.
			(2)	"	"	"		Sediment-O-G,Cd,Pb,Zn,Hg
	146-2	2/9/74	Hole B (1) 2D-181	CofE	LFE	Core		Same as Hole A (1)
			(2)	"	"	"		" " "
	147-2	2/9/74	Hole D (1) 2D-179	CofE	LFE	Core		
			(2)	"	"	"		
	148-2	2/9/74	Hole C (1) 2D-180	CofE	LFE	Core		Elutriate-IOD,BOD,S.S.,P, NO_3,TKN,Pest. Sediment-O-G,Cd,Pb,Zn,Hg
			(2)	"	"	"		Same as Hole C (1)
	149-2	2/22/74	2D-179 PT 1	CofE	LFE	Core	0-2.5	Elutriate-IOD,BOD,S.S.,P, NO_3,TKN,Pest. Sediment: O-G,Cd,Pb,Zn,Hg
			PT 2	"	"	"	2.5-5.0	Same as 2D-179 PT-1
	150-2	2/22/74	2D-180 PT 1	CofE	LFE	Core	0-2.5	Same as 2D-179 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
	151-2	2/22/74	2D-181 PT 1	CofE	LFE	Core	0-2.5	Same as 2D-179 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
	152-2	2/22/74	2D-182 PT 1	CofE	LFE	Core	0-2.5	Same as 2D-179 PT-1
			PT 2	"	"	"	2.5-5.0	" " "

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Mare Island Strait	4-3	5/17/71	64FA051	CofE	EPA	Grab	Surf.	V.S.,COD,TKN,Hg,Pb, Zn,Cd,As,Cu,Cr
	5-3	8/28/72	Sta 1B	CofE	CofE	Core	0-.75	V.S.,COD,TKN,O-G,Hg,Pb,Zn, Cu,Cd,As,Cr,Ni
			Sta 1A	"	"	"	.75-1.0	Same as Sta 1B
	6-3	8/28/72	Sta 2B	CofE	Pacific	Core	0-.75	V.S.,COD,TKN,O-G,Hg,Pb,Zn, Cu,Cd,As,Cr,Ni,Pest.
			Sta 2A	"	Envir	"	.75-1.0	Same as Sta 2B
	7-3	8/28/72	Sta 3B	CofE	CofE	Core	0-.75	Same as Sta 2B
			Sta 3A	"	"	"	.75-1.0	" " "
	8-3	8/28/72	Sta 4B	CofE	Pacific Envir.	Core	0-.75	Same as Sta 1B
			Sta 4A	"		"	.75-1.0	" " "
	9-3	8/28/72	Sta 5B	CofE	Pacific Envir.	Core	0-.75	Same as Sta 2B
			Sta 5A	"		"	.75-1.0	" " "
	10-3	8/28/72	Sta 6B	CofE	CofE	Core	0-.75	Same as Sta 2B
			Sta 6A	"	"	"	.75-1.0	" " "
	11-3	8/28/72	Sta 7B	CofE	Pacific Envir.	Core	0-.75	Same as Sta 1B
			Sta 7A	"		"	.75-1.0	" " "
	12-3	8/28/72	Sta 8B	CofE	Pacific Envir.	Core	0-.75	Same as Sta 2B
			Sta 8A	"		"	.75-1.0	" " "
	13-3	8/28/72	Sta 9B	CofE	Pacific Envir.	Core	0-.75	Same as Sta 2B
			Sta 9A	"		"	.75-1.0	" " "
	14-3	8/28/72	Sta 10B	CofE	Pacific Envir.	Core	0-.75	V.S.,COD,TKN,O-G,Hg,Pb,Zn, Cu,Cd,As,Cr,Ni
			Sta 10A	"	"	"	.75-1.0	Same as Sta 10B
	15-3	8/28/72	Sta 11B	CofE	Pacific Envir.	Core	0-.75	V.S.,COD,TKN,Hg,O-G,Pb,Zn, Cu,Cd,As,Cr,Ni,Pest.
			Sta 11A	"	"	"	.75-1.0	Same as Sta 11B
	16-3	8/28/72	Sta 12B	CofE	Pacific Envir.	Core	0-.75	Same as Sta 10B
			Sta 12A	"	"	"	.75-1.0	" " "
	17-3	8/28/72	Sta 13B	CofE	Pacific Envir.	Core	0-.75	Same as Sta 10B
			Sta 13A	"	"	"	.75-1.0	" " "
	18-3	8/28/72	Sta 14B	CofE	Pacific Envir.	Core	0-.75	Same as Sta 11B
			Sta 14A	"	"	"	.75-1.0	" " "
	19-3	8/28/72	Sta 15B	CofE	Pacific Envir.	Core	0-.75	Same as Sta 11B
			Sta 15A	"	"	"	.75-1.0	" " "
	20-3	8/28/72	Sta 16B	CofE	Pacific Envir.	Core	0-.75	Same as Sta 10B
			Sta 16A	"	"	"	.75-1.0	" " "
	21-3	8/28/72	Sta 17B	CofE	Pacific Envir.	Core	0-.75	Same as Sta 11B
			Sta 17A	"	"	"	.75-1.0	" " "
	22-3	8/28/72	Sta 18B	CofE	Pacific Envir.	Core	0-.75	Same as Sta 11B
			Sta 18A	"	"	"	.75-1.0	" " "
	23-3	9/72	Sta 1	CofE	CofE	Core	0-1.5	Hg,Pb,Zn,Cd,Cu,Cr, As,Ni
	24-3	9/72	Sta 2	"	"	"	0-1.5	Same as Sta 1
	25-3	9/72	Sta 8	"	"	"	0-1.5	" " "
	26-3	9/72	Sta 9	"	"	"	0-1.5	" " "

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Mare Island Strait (Cont'd)	27-3	9/72	Sta 10	CofE	CofE	Core	0-1.5	Same as Sta 1
	28-3	9/72	Sta 11	"	"	"	0-1.5	" " "
	29-3	9/72	Sta 14	"	"	"	0-1.5	" " "
	30-3	9/72	Sta 16	"	"	"	0-1.5	" " "
	31-3	8/73	PC809	CofE	CofE	Water	Disposal Site	Elutriate Only: DO,BOD, Salin,S.S.,TKN,NO_3,P, O-G,SO_4,Pb,Cu,Hg,Cd
	32-3	8/73	2D-108 PT 1	CofE	CofE	Core	0-2.5	Elutriate Only: IOD, V.S.,Salin,S.S.,TKN,NO_3, P,O-G,SO_4,Pb,Cu,Hg,Cd
			PT 2	"	"	"	2.5-5.0	Same as PT-1
			PT 3	"	"	"	5-7.5	" " "
	33-3	8/73	2D-109 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-108
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5-7.5	" " "
	34-3	8/73	2D-110 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-108
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
	35-3	8/73	2D-111 PT 1	CofE	CofE	Core	0-2.5	IOD
			PT 2	"	"	"	2.5-5.0	Same as 2D-108
			PT 3	"	"	"	5-7.5	" " "
	36-3	8/73	2D-112 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-108
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5-7.5	" " "
	140-3		2D-113 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-108
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
	37-3	2/6/73	CH73WS20	CofE	CofE	Water	Surface	COD,TKN,Hg,Zn,Pb,Cu,Cr,Ni
			S20F	"	"	"	"	Same as CH73WS20
	38-3	2/6/73	CH73WS21	CofE	CofE	Water	Bottom	Same as CH73WS20
			S21F	"	"	"	"	" " "
	39-3	2/13/73	CH73WS22	CofE	CofE	Water	Surface	Same as CH73WS20
			S22F	"	"	"	"	" " "
	40-3	2/13/73	CH73WS23	CofE	CofE	Water	Bottom	Same as CH73WS20
			S23F	"	"	"	"	" " "
	41-3	2/13/73	CH73WS24	CofE	CofE	Water	Surface	Same as CH73WS20
			S24F	"	"	"	"	" " "
	42-3	2/13/73	CH73WS25	CofE	CofE	Water	Bottom	Same as CH73WS20
			S25F	"	"	"	"	" " "
	43-3	2/13/73	CH73WS26	CofE	CofE	Water	Surface	Same as CH73WS20
			S26F	"	"	"	"	" " "
	44-3	2/13/73	CH73WS27	CofE	CofE	Water	Bottom	Same as CH73WS20
			S27F	"	"	"	"	" " "
	45-3	2/13/73	CH73WS28	CofE	CofE	Water	Surface	Same as CH73WS20
			S28F	"	"	"	"	" " "
	46-3	2/13/73	CH73WS29	CofE	CofE	Water	Bottom	Same as CH73WS20
			S29F	"	"	"	"	" " "
	47-3	2/13/73	CH73WS30	CofE	CofE	Water	Surface	Same as CH73WS20
			S30F	"	"	"	"	" " "
	48-3	2/13/73	CH73WS31	CofE	CofE	Water	Bottom	COD,TKN,Hg,Zn,Pb,Cu,Cr,Ni
			S31F	"	"	"	"	Same as CH73WS31
	49-3	1/9/73	CH73WS1	CofE	CofE	Water	Surface	Same as CH73WS31
			S1F	"	"	"	"	" " "
	50-3	1/9/73	CH73WS2	CofE	CofE	Water	Bottom	Same as CH73WS31
			S2F	"	"	"	"	" " "

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Mare Island Strait (Cont'd)	51-3	1/9/73	CH73WS3	CofE	CofE	Water	Surface	Same as CH73WS31
			S3F	"	"	"	"	" " "
	52-3	1/9/73	CH73WS4	CofE	CofE	Water	Bottom	Same as CH73WS31
			S4F	"	"	"	"	" " "
	53-3	1/9/73	CH73WS5	CofE	CofE	Water	Surface	Same as CH73WS31
			S5F	"	"	"	"	" " "
	54-3	1/9/73	CH73WS6	CofE	CofE	Water	Bottom	Same as CH73WS31
			S6F	"	"	"	"	" " "
	55-3	1/9/73	CH73WS7	CofE	CofE	Water	Surface	Same as CH73WS31
			S7F	"	"	"	"	" " "
	56-3	1/9/73	CH73WS8	CofE	CofE	Water	Bottom	Same as CH73WS31
			S8F	"	"	"	"	" " "
	57-3	1/9/73	CH73WS9	CofE	CofE	Water	Surface	Same as CH73WS31
			S9F	"	"	"	"	" " "
	58-3	1/23/73	CH73WS10	CofE	CofE	Water	Surface	COD,TKN,Hg,Zn,Pb,Cu,Cr,Ni
			S10F	"	"	"	"	Same as CH73WS10
	59-3	1/23/73	CH73WS11	CofE	CofE	Water	Bottom	Same as CH73WS10
			S11F	"	"	"	"	" " "
	60-3	1/23/73	CH73WS12	CofE	CofE	Water	Surface	Same as CH73WS10
			S12F	"	"	"	"	" " "
	61-3	1/23/73	CH73WS13	CofE	CofE	Water	Bottom	Same as CH73WS10
			S13F	"	"	"	"	" " "
	62-3	1/23/73	CH73WS14	CofE	CCoF	Water	Surface	Same as Ch73WS10
			S14F	"	"	"	"	" " "
	63-3	1/23/73	CH73WS15	CofE	CofE	Water	Bottom	Same as CH73WS10
			S15F	"	"	"	"	" " "
	64-3	1/23/73	CH73WS16	CofE	CofE	Water	Surface	Same as CH73WS10
			S16F	"	"	"	"	" " "
	65-3	2/6/73	CH73WS17	CofE	CofE	Water	Bottom	Same as CH73WS10
			S17F	"	"	"	"	" " "
	66-3	2/6/73	CH73WS18	CofE	CofE	Water	Surface	Same as CH73WS10
			S18F	"	"	"	"	" " "
	67-3	2/6/73	CH73WS19	CofE	CofE	Water	Bottom	Same as CH73WS10
			S19F	"	"	"	"	" " "
	146-3	6/31/74	2D-117 PT 1	CofE	Engineering Science, Inc	Core	0-2.5	Elutriate: IOD,BOD,S.S., P,N,TKN Sediment: O-G,Cd,Zn,Pb,Hg
			PT 2	"	"	"	2.5-5.0	Same as 2D-117 PT-1
			PT 3	"	"	"	5.0-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
			PT 5	"	"	"	10.0-12.5	" " "
	147-3	6/31/74	2D-116 PT 1	CofE	ESI	Core	0-2.3	Same as 2D-117 PT-I
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5.0-6.7	" " "
			PT 4	"	"	"	6.7-9.2	" " "
	148-3	6/31/74	2D-115 PT 1	CofE	ESI	Core	0-2.5	Same as 2D-117 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
			PT 5	"	"	"	10-12.5	" " "
			PT 6	"	"	"	12.5-14.0	" " "
	149-3	6/31/74	Receiving Water	"	"	Water		IOD,BOD,S.S.,P,NO_3,TKN
	150-3	6/31/74	2D-114 PT 1	CofE	ESI	Core	0-1.8	Same as 2D-117 PT-1
			PT 2	"	"	"	1.8-3.9	" " "
			PT 3	"	"	"	3.9-6.4	" " "
			PT 4	"	"	"	6.4-8.6	" " "

TABLE 1-1 (Cont'd)

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Mare Island Strait (Cont'd)	151-3	6/7/74	2D-118 PT-1	CofE	Frederiksen Engineering	Core	0-2.5	Elutriate: S.S., IOD, BOD P, NO_3, TKN, Pest. Sediment: T.S., O-G, Hg, Pb, Zn, Cd
			PT 2	"	"	"	2.5-5.0	Same as 2D-118 PT-1
			PT 3	"	"	"	5.0-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
	152-3	6/7/74	2D-119 PT 1	CofE	Frederiksen	Core	0-2.5	Same as 2D-118 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5.0-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
	153-3	6/7/74	2D-120 PT 1	CofE	Frederiksen	Core	0-2.5	Same as 2D-118 PT-1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5.0-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
			PT 5	"	"	"	10.0-12.5	" " "
	154-3	6/7/74	2D-121 PT 1	CofE	Frederiksen	Core	0-2.5	Same as 2D-118 PT-1
			PT 2	"	"	"	2.5-4.0	" " "
	155-3	6/7/74	2D-122 PT 1	CofE	Frederiksen	Core	0-2.5	Same as 2D-118 PT 1
	156-3	6/7/74	2D-123 PT 1	CofE	Frederiksen	Core	0-2.5	Same as 2D-118 PT 1
			PT 2	"	"	"	2.5-5.0	" " "
	157-3	6/7/74	2D-124 PT 1	CofE	Frederiksen	Core	0-2.5	Same as 2D-118 PT 1
			PT 2	"	"	"	2.5-5.0	" " "
	158-3	6/7/74	2D-125 PT 1	CofE	Frederiksen	Core	0-2.5	Same as 2D-118 PT 1
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5.0-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "

TABLE 1-1

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS	
Petaluma Creek									
	68-3	9/9/71	31FA091	CofE	EPA	Grab	Surf.	V.S.,COD,TKN,Hg,Pb, Zn,O-G	
	69-3	9/9/71	32FA091	"	"	"	"	Same as 31FA091	
	70-3	9/9/71	33FA091	"	"	"	"	" " "	
Beacon #6	71-3	6/1/72	PC413	CofE	CofE	Grab	Surf.	V.S.,COD,TKN,O-G, Hg,Pb,Zn	
Beacon #14	72-3	6/1/72	PC414	"	"	"	"	Same as PC413	
Beacon #18	73-3	6/1/72	PC415	"	"	"	"	" " "	
	74-3	11/30/73	2D-164	CofE	CofE	Core Water	0-.5	Sediment: O-G,Hg,Cd,Pb,Zn Elutriate: IOD,BOD,Solids P,NO_3,TKN,Pest	
	75-3	11/30/73	2D-165	"	"	"	"	Same as 2D-146	
	76-3	11/30/73	2D-166	"	"	"	"	" " "	
	77-3	11/30/73	2D-167	"	"	"	"	" " "	
	78-3	11/30/73	2D-168	"	"	"	"	" " "	
	79-3	11/30/73	2D-169	"	"	"	"	" " "	
	80-3	11/30/73	2D-170	"	"	"	"	" " "	Pest
	81-3	11/30/73	2D-171	"	"	"	"	" " "	"
	82-3	11/30/73	2D-172	"	"	"	"	" " "	"
	83-3	11/30/73	2D-173	"	"	"	"	" " "	"
	84-3	11/30/73	2D-174	"	"	"	"	" " "	"
	85-3	11/30/73	2D-175	"	"	"	"	" " "	"
	86-3	11/30/73	2D-176	"	"	"	"	" " "	"
	87-3	11/30/73	2D-177	"	"	"	"	" " "	"
	88-3	11/30/73	2D-178	"	"	"	"	" " "	"

TABLE 1-1

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Pinole Shoal	89-3	11/8/71	2D-22 #9	CofE	EPA	Core	0-2.5	V.S.,COD,TKN,Hg,Pb,Zn, O-G
	90-3	11/8/71	2D-23 #10	"	"	"	0-2.5	Same as #9
	91-3	11/9/71	2D-25 #12	"	"	"	0-2.5	" " "
	92-3	11/9/71	2D-24 #11	"	"	"	0-2.5	" " "
	93-3	11/8/71	2D-21 #8	"	"	"	0-2.5	" " "
	94-3	11/4/71	2D-20 #7	"	"	"	0-2.5	" " "
	95-3	10/20/71	2D-14 #1	"	"	"	0-2.5	" " "
	96-3	10/20/71	2D-15 #2	"	"	"	0-2.5	" " "
	97-3	10/20/71	2D-16 #3	"	"	"	0-2.5	" " "
	98-3	10/22/71	2D-19 #6	"	"	"	0-2.5	" " "
	99-3	10/21/71	2D-17 #4	"	"	"	0-2.5	" " "
	100-3	10/21/71	2D-18 #5	"	"	"	0-2.5	" " "
	101-3	10/4/71	2D-16					
			PC272	CofE	CofE	Core	0-.6	V.S.,COD,TKN,O-G, Hg,Pb Zn,Pest.
			PC273	"	"	"	3.2-3.8	
			PC274	"	"	"	6.9-7.5	Same as PC272
	102-3	10/4/71	2D-20					
			PC360	CofE	CofE	Core	0-.6	Same as PC272
			PC361	"	"	"	7.5-8.1	" " "
			PC362	"	"	"	14.4-15.0	" " "
	103-3	11/19/73	PC954	CofE	CofE	Water	Disposal Site	DO,BOD,S.S.,P,NO_3,TKN Pest.
	104-3	11/19/73	2D-162(F)	CofE	CofE	Core	0-2.5	Elutriate: IOD,BOD,S.S., P,NO_3,TKN Sediment: O-G,Hg,Cd,Pb,Zn
	105-3	11/19/73	2D-163 (G)	CofE	CofE	Core	0-2.5	Same as 2D-162 (F)
	106-3	11/19/73	2D-152 (H)	CofE	CofE	Core	0-2.5	Same as 2D-162 (F)
	107-3	11/19/73	2D-153 (I)	CofE	CofE	Core	0-2.5	Same as 2D-162 (F)
	108-3	11/19/73	2D-154 (J)	CofE	CofE	Core	0-2.5	Same as 2D-162 (F)
	109-3	5/17/73	2D-52 PT 1	CofE	CofE	Core	0-2.5	V.S.,COD, TKN,O-G,Hg,Pb,Zn
			PT 2&3	"	"	"	2.5-7.5	Same as 2D-52 PT-1
			PT 4	"	"	"	7.5-10.0	" " "
	110-3	5/29/73	2D-57 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-52 PT-1
			PT 2&3	"	"	"	2.5-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
	111-3	6/1/73	2D-59 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-52 PT-1
			PT 2&3	"	"	"	2.5-7.5	" " "
	112-3	6/4/73	2D-61 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-52 PT-1
			PT 2&3	"	"	"	2.5-7.5	" " "
			PT 4&5	"	"	"	7.5-12.5	" " "
	113-3	6/4/73	2D-63 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-52 PT-1
			PT 2&3	"	"	"	2.5-7.5	" " "
			PT 4-6	"	"	"	7.5-15.0	" " "
	114-3	6/8/73	2D-65 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-52 PT-1
			PT 2&3	"	"	"	2.5-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
	115-3	6/21/73	2D-82 PT 1	CofE	CofE	Core	0-2.5	V.S.,COD, TKN,O-G,Hg,Pb,Zn
			PT 3&4	"	"	"	5-10.0	Same as 2D-82 PT-1
	116-3	6/21/73	2D-83 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-82 PT-1
			PT 2&3	"	"	"	2.5-7.5	" " "
	117-3	6/22/73	2D-84 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-82 PT-1
			PT 2&3	"	"	"	2.5-7.5	" " "
	118-3	6/25/73	2D-86 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-82 PT-1
			PT 2&3	"	"	"	2.5-7.5	" " "

TABLE 1-1

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Pinole Shoal (Cont'd)								
	119-3	6/27/73	2D-88 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-82 PT-1
			PT 2&3	"	"	"	2.5-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "
	120-3	7/9/73	2D-91 PT 1	CofE	CofE	Core	0-2.5	Same as 2D-82 PT-1
			PT 2&3	"	"	"	2.5-7.5	" " "
			PT 4	"	"	"	7.5-10.0	" " "

TABLE 1-1

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Napa River	121-3	7/29/71	2D-2M PT 1-8	CofE	CofE	Core		V.S.,COD,TKN,Hg,Pb, Zn,O-G,Mn
	122-3	7/30/71	2D-2N PT 1-16	"	"	"		Same as 2D-2M
	123-3	7/29/71	2D-2P PT 1-8	"	"	"		Same as 2D-2M
	124-3	8/2/71	2D-2J PT 1-16	"	"	"		Same as 2D-2M
	125-3	8/5/71	2D-2A PT 1-3	"	"	"		Same as 2D-2M
	126-3	8/2/71	2D-2K PT 1-9	"	"	"		Same as 2D-2M
	127-3	8/3/71	2D-2G PT 1-8	"	"	"		Same as 2D-2M
	128-3	8/3/71	2D-2D PT 1-2	"	"	"		Same as 2D-2M
	129-3	8/3/71	2D-2H PT 1-5	"	"	"		Same as 2D-2M
	130-3	8/4/71	2D-2E PT 1-4	"	"	"		Same as 2D-2M
	131-3	8/4/71	2D-2F PT 1-4	"	"	"		Same as 2D-2M
	142-3	11/71	2D-20 J-1	CofE	CofE	Suspended Sed	--	S.S.,V.S.,COD,TKN, O-G,pH,Pb,Zn,Hg,Pest.
			PT 1	"	"	Core	0.0-.5	V.S.,COD,TKN, O-G,pH,Pb,Zn,Hg,Pest.
			PT 7	"	"	"	3.8-4.3	Same as 2D-20 PT-1
			PT 12	"	"	"	6.8-7.5	" " "
	143-3	11/71	2D-2B PT 1	CofE	CofE	Core		Same as 2D-20 PT-1
	144-3	11/71	2D-2C J-1	CofE	CofE	Suspended Sed		Same as 2D-20 J-1
			PT 1	"	"	Core		Same as 2D-20 PT-1
	145-3	11/71	2D-2L J-1	CofE	CofE	Suspended Sed		Same as 2D-20 J-1
			PT 1	"	"	Core	0.0-.5	Same as 2D-20 PT-1
			PT 8	"	"	"	4.5-5.0	" " "
			PT 16	"	"	"	8.7-10.0	" " "

TABLE 1-1

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Sonoma Creek	132-3	8/10/71	2D-1(7) PT 1-4	CofE	EPA	Core		V.S.,COD,TKN,Hg,Pb,Zn, O-G,Mn
	133-3	8/10/71	2D-2(6) PT 1-4	CofE	EPA	Core		Same as 2D-1(7)
	134-3	8/12/71	2D-6(3) PT 1-12	CofE	EPA	Core		Same as 2D-1(7)
	135-3	8/11/71	2D-4(1) PT 1-17	CofE	EPA	Core		Same as 2D-1(7)
	136-3	8/12/71	2D-7(4) PT 1-6	CofE	EPA	Core		Same as 2D-1(7)
	141-3	11/71	2D-5(2) J-1	CofE	CofE	Suspended Sed		S.S.,V.S.,COD,TKN, O-G,pH,Pb,Zn,Hg, Pest. + BOD
			PJ 1	"	"	Core	0.0-.4	S.S.,V.S.,COD,TKN, O-G,pH,Pb,Zn,Hg,Pest.
			PJ 9	"	"	"	3.4-3.8	" " "
			PJ 18	"	"	"	7.1-7.5	" " "

TABLE 1-1

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Suisun Bay	19-4	7/72	5F-21	CofE	CofE	Core		TKN,V.S.,COD,O-G,Hg, Pb,Zn
	20-4	7/72	5F-22	CofE	"	Core		Same as 5F-21
	21-4	7/72	5F-23	CofE	"	Core		" " "
	22-4	7/72	5F-24	CofE	"	Core		" " "
	23-4	7/72	5F-25	CofE	"	Core		" " "
	24-4	7/72	5F-26	CofE	"	Core		" " "
	25-4	7/74	PC-1431					
			Disp. Site 1	CofE	CofE	Water		BOD,P,NO_3,TKN,Pest.
			Disp. Site 2	"	"	"		" " "
	26-4	7/74	2D-1					
			Site 1 PT 1	"	"	Core	0.0-1.7	Elutriate: IOD,BOD,P, NO_3,TKN,Pest.
			Site 2 PT 1	"	"	"	" "	" " "
	27-4	7/74	2D-2 PT 1	CofE	CofE	Core	0.0-2.3	Same as 2D-1 PT-1
			PT 1	"	"	"	" "	" " "
			PT 2	"	"	"	2.5-3.8	" " "
			PT 2	"	"	"	" "	" " "
	28-4	7/74	2D-3 PT 1	CofE	CofE	Core	0.0-1.5	Same as 2D-1 PT 1
			PT 1	"	"	"	" "	" " "
			PT 2	"	"	"	1.5-3.5	" " "
			PT 2	"	"	"	" "	" " "
	29-4	7/74	2D-4 PT 1	CofE	CofE	Core	0.0-2.1	Same as 2D-1 PT-1
			PT 1	"	"	"	" "	" " "
			PT 2	"	"	"	2.5-4.7	" " "
			PT 2	"	"	"	" "	" " "
			PT 3	"	"	"	5.0-7.1	" " "
			PT 3	"	"	"	" "	" " "
			PT 4	"	"	"	7.5-8.6	" " "
			PT 4	"	"	"	" "	" " "
	30-4	7/74	2D-5 PT 1	CofE	CofE	Core	0.0-2.5	Same as 2D-1 PT-1
			PT 1	"	"	"	" "	" " "
	31-4	7/74	2D-6 PT 1	CofE	CofE	Core	0.0-2.3	Same as 2D-1 PT-1
			PT 1	"	"	"	" "	" " "
			PT 2	"	"	"	2.5-4.8	" " "
			PT 2	"	"	"	" "	" " "
			PT 3	"	"	"	5.0-6.5	" " "
			PT 3	"	"	"	" "	" " "
	32-4	7/74	2D-7 PT 1	CofE	CofE	Core	0.0-2.2	Same as 2D-1 PT 1
			PT 1	"	"	"	" "	" " "
			PT 2	"	"	"	2.5-4.7	" " "
			PT 2	"	"	"	" "	" " "
	33-4	7/74	2D-8 PT 1	CofE	CofE	Core	0.0-2.5	Same as 2D-1 PT-1
			PT 1	"	"	"	" "	" " "
			PT 2	"	"	"	2.5-5.0	" " "
			PT 2	"	"	"	" "	" " "
	34-4	7/74	2D-9 PT 1	CofE	CofE	Core	0.0-2.4	Same as 2D-1 PT-1
			PT 1	"	"	"	" "	" " "
	35-4	7/74	2D-10 PT 1	CofE	CofE	Core	0.0-2.4	Same as 2D-1 PT-1
			PT 1	"	"	"	" "	" " "
	36-4	7/74	2D-11 PT 1	CofE	CofE	Core	0.0-2.0	Same as 2D-1 PT-1
			PT 1	"	"	"	" "	" " "

TABLE 1-1

LOCATION	INDEX NO.	DATE	SAMPLE NUMBER	TAKEN BY	ANALYSED BY	TYPE	DEPTH FT.	PARAMETERS
Carquinez Strait	1-4	6/12/73	2D-66					
			PT 1& 2	CofE	CofE	Core	0-5.0	V.S.,COD, TKN,O-G,Hg,Pb,Zn
			PT 3	"	"	"	5-7.5	Same as 2D-66 PT 1&2
	2-4	6/12/73	2D-67					
			PT 1	CofE	CofE	Core	0-2.5	Same as 2D-66 PT 1&2
	3-4	6/12/73	2D-68					
			PT 1	CofE	CofE	Core	0-2.5	Same as 2D-66 PT 1&2
			PT 2&3	"	"	"	2.5-7.5	" " "
			PT 4&5	"	"	"	7.5-12.5	" " "
			PT 6&7	"	"	"	12.5-17.5	" " "
			PT 8	"	"	"	17.5-20.0	" " "
	4-4	6/13/73	2D-69					
			PT 1&2	CofE	CofE	Core	0-5.0	Same as 2D-66 PT 1&2
	5-4	6/13/73	2D-70					
			PT 3	CofE	CofE	Core	5-7.5	Same as 2D-66 PT 1&2
	6-4	6/14/73	2D-72					
			PT 1	CofE	CofE	Core	0-2.5	Same as 2D-66 PT 1&2
			PT 2&3	"	"	"	2.5-7.5	" " "
	7-4	6/18/73	2D-76					
			PT 1	CofE	CofE	Core	0-2.5	Same as 2D-66 PT 1&2
			PT 2	"	"	"	2.5-5.0	" " "
			PT 3	"	"	"	5-7.5	" " "
	8-4	6/18/74	2D-77					
			PT 1	CofE	CofE	Core	0-2.5	V.S.,COD, TKN,O-G,Hg,Pb,Zn
			PT 2&3	"	"	"	2.5-7.5	Same as 2D-77 PT-1
			PT 4&5	"	"	"	7.5-12.5	" " "
			PT 6	"	"	"	12.5-15.0	" " "
	9-4	6/19/73	2D-78					
			PT 1	CofE	CofE	Core	0-2.5	Same as 2D-77 PT-1
			PT 2&3	"	"	"	2.5-7.5	" " "
			PT 4&5	"	"	"	7.5-12.5	" " "
	10-4	7/24/71	13264 Sta A	Benicia Ind.	Brown & Caldwell	Grab	Surface	V.S.,COD,TKN,O-G,Hg, Pest.
	11-4	7/24/71	13265 Sta B	Benicia Ind.	Brown & Caldwell	Grab	Surface	Same as Sta A
	12-4	7/24/71	13266 Sta C	Benicia Ind.	Brown & Caldwell	Grab	Surface	Same as Sta A
	13-4	11/23/71	2D-30 #5	CofE	CofE	Core	0-2.5	TKN,Hg,Pb,Zn,O-G
	14-4	11/19/71	2D-26 #1	CofE	CofE	Core	0-2.5	Same as 2D-30 #5
	15-4	11/23/71	2D-31 #6	CofE	CofE	Core	0-2.5	Same as 2D-30 #5
	16-4	11/22/71	2D-27 #2	CofE	CofE	Core	0-2.5	Same as 2D-30 #5
	17-4	11/22/71	2D-28 #3	CofE	CofE	Core	0-2.5	Same as 2D-30 #5
	18-4	11/23/71	2D-29 #4	CofE	CofE	Core	0-2.5	Same as 2D-30 #5

REPORTED AS % OF DRY WEIGHT

Index No.	Location	DATE	DEPTH	V.S.	C.O.D.	TKN	OIL & GREASE	Hg $\times10^{-4}$	Pb $\times10^{-4}$	Zn $\times10^{-4}$	Cd $\times10^{-4}$	Cu $\times10^{-4}$	Cr $\times10^{-4}$	As $\times10^{-4}$	Ni $\times10^{-4}$	SO_4 $\times10^{-4}$	PO_4 $\times10^{-4}$	N $\times10^{-4}$	S $\times10^{-4}$	B.O.D. mg/l	CN $\times10^{-4}$	SS mg/l	PEST $\times10^{-7}$
1-1	San Leandro	2/1/72	Surf.	9.6	5.7	0.24	0.17	0.20	80	161													
2-1	Marina	2/1/72	Surf.	8.0	5.9	0.19	.07	0.14	52	133													
3-1		2/1/72	Surf.	8.1	4.3	0.18	.05	0.20	54	132													
4-1		2/1/72	Surf.	9.2	5.2	0.23	.13	0.15	75	152													
5-1		2/1/72	Surf.	8.3	4.9	0.19	.19	0.20	75	161													
6-1	Redwood City	4/5-6/71	Suspended		2.96	0.186		0.570	32	76	1.77	28	16	1.205	33	9,379	42	.1865	291	<10	0.2	158,000	D
	Harbor		Sediment																				
			0-1		3.58	0.180		0.801	21	102	0.84	53	28	1.200	40	3,433	991	.1817	391	<			D
7-1		4/5-6/71	Suspended		1.63	0.205		0.556	32	78	0.35	26	26	0.281	36	15,383	12	.2058	70	< 5	0.3	115,000	D
			0-1		0.35	0.04								1.549			24	.0404	26				D
8-1		4/5-6/71	Suspended		1.93	0.133		0.504	16	55	0.78	21	23	2.667	37	11,468	13	.1330	14	<15	0.2	141,000	D
			Sediment																				
			1-2.5		4.17	0.714		1.239	20	106	0.66	50	34	3.875	43	4,780	90	.1755	39				D
9-1		4/5-6/71	Suspended		1.35	0.097		0.455	26	56	1.25	17	26	2.864	42	20,819	38	.0977	91	<25	0.3	88,000	D
			Sediment																				
			0-2.5		3.90	0.275								1.163			125	.2758	206				D
			2.5-5		3.93	0.144		0.246	5	41	0.42	22	16	0.417	17	455	938	.1452	46				D
10-1		4/5-6/71	Suspended		3.41	0.080		0.410	31	59	2.30	31	26	3.295	43	31,000	62	.0810	33	< 6	0.3	61,000	D
			Sediment																				
			0-2.5		6.70	0.293		0.242	11	63	0.47	19	20	0.140	41	4,265	1	.2933	29				
			2.5-2		6.05	0.177								0.081			78	.1774	64				
11-1		8/6/71					.008	0.001	0.04	0.1	0.004	0.1	<0.01	0.01	<0.03			.56			002		D
12-1		9/8/71		8.1	4.8	0.19	0.06	0.40	58	130													
13-1		9/8/71		7.6	4.8	0.18	0.05	0.35	55	123													
14-1		8/29/72	.75-1.5	4.56	1.79	.0124	.0227	0.12	28	215	2.9	40	55	<.35	72								D
			0-0.75	6.73	3.56	.0179	.0437	.586	65	247	4.3	60	82	<.51	95								D
15-1		8/29/72	.75-1.5	4.91	.851	.0108	.0191	.193	32	137	2.6	34	57	<.27	73								D
			0-0.75	7.55	4.30	.0182	.0250	.479	204	276	4.8	62	86	<.50	86								D
16-1		8/29/72	.75-1.5	0.78	2.27	.0142	.0212	.353	71	176	3.5	53	71	<.35	92								D
			0-.75	7.39	4.40	.0232	.1040	.625	286	263	4.6	69	87	<.51	73								D
17-1		8/29/72	.75-1.5	7.50	4.82	.0216	.0869	.305	154	343	4.7	76	85	<.44	90								D
			0-.75	8.00	3.30	.0159	.1102	.407	111	243	4.1	41	69	<.39	73								D
18-1		8/29/72	.75-1.5	7.86	9.34	.0147	.1623	.124	35	150	3.5	39	81	<.35	141								D
			0-.75	6.86	5.58	.0173	.0842	.219	74	151	4.0	57	77	<.42	89								D
19-1																							
		8/29/72	.75-1.5	6.99	6.37	.0382	.0962	.106	99	113	4.0	36	64	.41	56								D
		"	0- .75	6.38	5.18	.0197	.0934	.391	77	154	3.8	31	73	.42	69								D
		8/29/72	.75-1.5	4.91	6.66	.0288	.0340	.168	40	89	3.2	42	77	.34	99								D
20-1		"	0- .75	5.41	5.39	.0143	.1058	.260	116	116	3.6	47	82	.34	97								D
21-1	Coyote Pt. Marina	2/2/72	SURF.	2.78	2.35	0.09	0.24	1.0	32	84													
22-1		2/2/72	SURF.	2.73	1.06	0.08	0.15	0.140	30	80													
25-1	San Bruno	4/27-30/72	Suspended		1.84	0.11	.171	.171	14	63	0.43	24	24	1.72	13	10,275	1402	.1088	91		.2	164,000	D
	Channel		Sediment																				
			0-2.5		3.43	0.31	0.1	.602	7	47	0.61	26	23	.768	36	2,782	99	.3146	982				D
			25-5.0		1.19	0.18	0.1																D
			5-7.5		4.26	0.19	0.1	.235	6	47	0.56	21	19	.314	32	1,987	163	.1940	75				D
26-1		4/27-30/71	Suspended																	10			
			Sediment																				
			0-2.5		2.91	0.10		.170	7	36	0.66	12	9	1.299	22	4,012	1204	.1061	8				D
			2.5-4.2		3.12	0.14								.137					4				
			5-6.3		2.80	0.08		.226	7	22	0.84	15	1	.846	17	3,343	1671	.0909	4				
27-1		4/27-30/71	Suspended																	6			
			Sediment																				
			0-2.5		0.23	0.03		.189	4	26	0.31	14	12	.298	18	488	874	.0313	6				
			2.5-3.7		0.24	0.03													3				
			5-6																				
			7.5-8		0.94	0.03		.169	4	45	0.42	19	9	1.154	16	1,853	19886	.0329	3				
28-1		4/27-30/71	0-2.5		3.98	0.12													21				
			7.5-10		2.01	0.08													7				
			12.5-15		3.72	0.11		.167	5	40	0.28	17	12	.243	24	1,175	1203	.1085	4				
29-1		4/27-30/71	Suspended		.67	0.15		.457	54	51	2.00	60	29	1.000	29	56,228	571	.1577	40	2	1	35,000	D
			Sediment																				
			0-2.5		1.77	0.06													103				
			5-7.5		2.33	0.38													14				
			10-12.5		4.82	0.13		.297	9	39	0.34	21	5	.557	30	1,516	1539	.1321	10				D
30-1	Islais Creek	5/3/71	Suspended		.69	0.08	0.1	.34	10	37	0.11	6	14	.053	19	3,887	1401	.0801	21		1	379,000	D
			Sediment																				
			0-2.5		5.51	0.24		.90	21	72	0.44	38	22		27	3,644	1876	.2383	984				D
			2.5-5		4.15	0.11													17				D
			5-7.5		4.60	0.19		.32	6	50	0.45	25	13	.511	23	734	1412	.1918	9				D
31-1		5/3/71	Suspended		0.54	0.13		0.55	20	66	0.94	17	18	.863	36	17,307	1205	.1311	1	0	0.3	117,000	
			Sediment																				
			0-2.5		4.06	0.21		1.44	12	44	0.43	20	16	2.577	28	894	1967	.2094	40				
			2.5-5		4.90	0.19													541				D
			5-7		2.84	0.08		0.73	7	23	0.34	7	8	1.380	19	1,589	1502	.0825	3				
32-1		5/3/71	Suspended		0.47	0.07		0.46	26	50	2.20	18	32	1.980	42	41,620	800	.0686	2	3	0.3	50,000	
			Sediment																				
			0-2.5		3.77	0.08	.07	0.86	16	79	0.48	33	17	0.708	25	3,580	1784	.0837	619				
			2.5-5		4.88	0.12													4				D
			5-7.5		4.23	0.10		0.17	6	38	0.76	21	11	1.468	20	916	1515	.1005	4				
33-1		5/3/71	Suspended		0.64	0.05		0.37	27	51	0.61	10	27	1.285	20	42,677	530	.0581	2	2	0.3	49,000	
			Sediment																				
			0-2.5		2.33	0.11		0.73	5	27	0.71	9	8	0.730	19	1,523	1062	.1104	7				
			2.5-5		3.40	0.15		0.30	8	43	0.70	28	11	0.166	24	889	1238	.1580	4				D

D: Detected

REPORTED AS % OF DRY WEIGHT

Index No.	Location	DATE	DEPTH	V.S.	COD	TKN	OIL & GREASE	Hg $x10^{-4}$	Pb $x10^{-4}$	Zn $x10^{-4}$	Cd $x10^{-4}$	Cr $x10^{-4}$	As $x10^{-4}$	Ni $x10^{-4}$	SO_4 x10-4	PO_4 x10-4	N x10-4	S x10-4	BOD mg/l	CN x10-4	SS mg/l	PEST x10-7
36-1	Islais Creek	2/15/74	ELUT. 0-2.5 Sed.			.0001	.0367	0.606	50	58	3.6						.00012		5		16.4	D
			ELUT. 2.5-5.0 Sed.			.00025	.0282	0.696	50	50	3.6						.00004		5		28.8	D
			ELUT. 5.0-7.5 Sed.			.00021	.0224	0.632	50	64	3.8						.00023		14.4		7.6	D
			ELUT. 7.5-10.0 Sed.			.00018	.0162	0.109	50	52	3.1						.00019		5		12.4	D
37-1		2/15/74	ELUT. 0.0-2.5 Sed.			.0019	.1015	1.164	40	60	2.7						.0002		5.6		14.4	D
			ELUT. 2.5-5.0 Sed.			.000032	.0651	0.491	33	56	2.2						.00005		5		16.4	D
			ELUT. 5.0-7.5 Sed.			.00032	.0705	0.633	35	75	2.3						.00033		5		16.4	D
			ELUT. 7.5-10.0 Sed.			.00053	.0407	0.581	40	70	3.3						.00053		22.1		14.2	D
38-1		2/15/74	ELUT. 0.0-2.5 Sed.			.00083	.0623	2.010	41	56	2.9						.00085		22.1		14.2	D
			ELUT. 2.5-5.0 Sed.			.00025	.09	5.634	46	82	3.0						.00027		23.4		28.2	D
			ELUT. 5.0-7.5 Sed.			.00012	.0195	2.006	43	79	2.9						.00014		21.0		19.8	D
			ELUT. 7.5-10.0 Sed.			.00122	.0218	0.692	29	79	1.9						.00124		41.0		217.8	D
39-1		2/15/74	ELUT. 0.0-2.5 Sed.			.00128	.131	2.894	46	103	3.3						.0013		5		50.2	D
			ELUT. 2.5-5.0 Sed.			.00032	.1511	2.298	41	64	2.7						.00033		19.2		30.6	D
			ELUT. 5.0-7.5 Sed.			.00054	.1008	0.455	36	60	2.4						.00054		15.0		34.6	D
			ELUT. 7.5-10.0 Sed.			.00073	.0642	0.340	33	60	3.4						.00074		38.6		42.0	D
40-1		2/15/74	ELUT. 0.0-2.5 Sed.			.00016	.0571	1.515	35	69	4.1						.00018		5		118.0	D
			ELUT. 2.5-5.0 Sed.			.00058	.0341	0.331	40	73	2.6						.00059		17.4		154.0	D
			ELUT. 5.0-7.5 Sed.			.00062	.0671	0.401	39	66	2.6						.00063		23.1		21.0	D
			ELUT. 7.5-10.0 Sed.			.00019	.0380	0.369	32	51	2.2											
41-1		2/15/74	Water			.000014											.000048		5		9.2	D
42-1		8/5/74	Water			.000063											.000073		4.8		2.2	D
43-1		8/5/74	ELUT. 0.0-2.5 Sed.			.00074	.036	0.7	15	63	2.4						.00078		2.0		2.4	D
			ELUT. 2.5-4.0 Sed.			.00062	.04	0.2	10	64	3.2						.00065		2.2		2.8	D
			ELUT. 4.0-6.5 Sed.			.00104	.027	0.6	10	62	4.F						.00107		5.1		37	D
			ELUT. 6.5-9.0 Sed.			.00089	.029	0.4	16	73	3.2						.0009		5.7		26	D
44-1		8/5/74	ELUT. 0.0-1.5 Sed.			.0013	.036	1.0	11	69	3.2						.00132		9.9		50	D
			ELUT. 1.5-4.0 Sed.			.00137	.038	0.6	17	72	4.8						.00139		2.7		24	D
			ELUT. 4.0-6.5 Sed.			.00016	.044	0.9	17	59	1.6						.00016		9.9		32	D
			ELUT. 6.5-9.0 Sed.			.00114	.038	0.2	14	68	1.6						.00114		3.9		37	D
45-1		8/5/74	ELUT. 0.0-2.5 Sed.			.00032	.041	0.2	19	96							.00034		5.1		58	D
			ELUT. 2.5-4.0 Sed.			.00012	.04	0.9	13	78							.00013		5.1		60	D
			ELUT. 4.0-6.5 Sed.			.00071	.034	0.3	17	76							.00072		4.5		65	D
			ELUT. 6.5-9.0 Sed.			.00066	.035	0.3	15	74							.00066		2.4		47	D
			ELUT. 9.0-11.5 Sed.			.00025	.04	0.3	21	69							.00026		8.1		48	D

D:Detected

REPORTED AS % OF DRY WEIGHT

Index No.	Location	Date	Depth	V.S.	COD	TKN	OIL & GREASE	Hg $x10^{-4}$	Pb $x10^{-4}$	Zn $x10^{-4}$	Cd $x10^{-4}$	Cu $x10^{-4}$	Cr $x10^{-4}$	As $x10^{-4}$	Ni $x10^{-4}$	SO_4 $x10^{-4}$	PO_4 $x10^{-4}$	N	S $x10^{-4}$	BOD mg/1	CN $x10^{-4}$	SS mg/1	PEST $x10^{-7}$
1-2	Sausalito Channel	2/2-5/71	Suspended Sediment		4.259	.0252		0.56	44	126	1.95	29	49	0.057	63	8689	2243	.0254	44	<10		159,000	
			0-2.5		4.673	.0233		0.55	15	110	0.90	32	26	0.029	26	4438	1420	.0238	8				
			5-7.5		4.851	.0330		0.26	6	66	0.92	14	20	0.038	22	7588	1377	.0344	8				
			10-12.5		7.529	.0443		0.27	6	60	0.86	13	24	0.173	28	5047	1333	.0450	<4				
2-2		2/2-5/71	Suspended Sediment		3.411	.0218		0.27	31	77	1.01	25	32	0.023	47	5335	1581	.0220	19	11		257,000	
			0-2.5		3.544	.0173		0.58	19	125	0.80	37	51	0.285	25	3572	2527	.0180	23				
			5-7.5		6.420	.0367		0.54	7	155	0.93	44	29	0.049	29	3976	1401	.0371	33				
			10-12.5		6.550	.0439		0.28	8	67	1.10	13	22	0.283	27	5694	1510	.0445	<4				
3-2		2/2-5/71	Suspended Sediment		2.808	.0169		0.43	29	88	0.74	22	32	0.004	44	4844	1367	.0171	74	30		272,000	
			0-2.5		4.350	.0193		0.55	20	130	0.99	37	43	0.050	26	4946	1509	.0197	26				
			5-7.5		6.207	.0301		0.24	89	57	0.75	13	20	0.041	21	5199	1676	.0306	23				
			10-12.5		7.537	.0475		0.46	8	89	1.14	20	26	0.369	25	5817	1755	.0479	<4				
4-2		2/2-5/71	Suspended Sediment		3.119	.0153		0.44	37	133	0.83	22	41	0.004	49	5760	1325	.0160	75	<10		241,000	
			0-2.5		4.714	.0176		0.38	30	138	0.92	29	24	0.030	28	3990	2978	.0179	594				
			5-7.5		5.060	.0221		0.19	5	41	0.99	6	10	0.019	14	4924	1364	.0226	12				
			10-12.5		7.071	.0310		0.15	6	71	0.99	17	22	0.046	26	5003	1643	.0316	12				
5-2		2/2-5/71	Suspended Sediment		2.881	.0165		0.34	24	82	1.79	20	30	0.340	45	5148	1192	.0166	607	217		291,000	
			0-2.5		4.214	.0163		0.55	15	93	0.64	33	21	0.008	28	5299	1119	.0166	432				
			2.5-5		3.030	.0126		0.33	6	74	0.77	26	16	0.255	23	2753	1600	.0129	6		0.32		
			5-7.5		4.447	.0255		10.48	17	88	0.88	32	19	0.015	29	3379	1465	.0261	90				
6-2		2/2-5/71	Suspended Sediment		2.646	.0160		0.38	21	82	1.57	21	32	0.009	39	4333	1509	.0161	100	80		331,000	
			0-2.5		4.599	.0150		0.36	8	74	0.83	20	13	0.012	20	3493	1459	.0157	83				
			2.5-5		3.765	.0226		0.42	5	54	1.04	10	19	0.139	22	4581	1359	.0230	<3		0.19		
			5-7.5		3.944	.0266		0.44	5	48	0.78	10	13	0.344	20	2886	1581	.0272	5				
7-2		2/2-5/71	Suspended Sediment		2.728	.0191		0.69	31	113	2.42	29	48	0.010	52	8514	1887	.0192	722	47		194,000	
			0-2.5		3.979	.0201		0.63	14	80	0.68	33	19	0.007	27	5265	1123	.0206	94		0.11		
			2.5-5		6.636	.0314		0.48	15	106	1.14	37	25	0.015	30	5531	1959	.0326	560				
8-2		2/2-5/71	Suspended Sediment		0.935	.0156		0.39	17	82	1.41	21	30	0.003	41	4609	1550	.0158	120	90		291,000	
			0-2.5		4.561	.0121		0.37	8	44	1.14	12	13	0.013	24	4857	1483	.0126	13				
			2.5-5		3.486	.0163		0.43	3	47	0.75	10	14	0.125	23	4497	1363	.0171	<3		0.09		
			5-7.5		3.572	.0254		0.30	3	40	0.65	10	17	0.178	23	4001	1198	.0258	<3				
			7.5-10		6.120	.0270		3.28	24	44	0.61	11	17	0.309	24	4156	1533	.0274	14				
9-2		2/2-5/71	Suspended Sediment		3.022	.0201		0.29	5	55	1.07	15	24	0.003	31	3638	1393	.0202	371	157		382,000	
			0-2.5		4.331	.0126		0.30	8	72	0.75	25	18	0.036	26	4224	1620	.0136	44				
			2.5-5		4.735	.0169		0.21	7	46	0.62	12	16	0.139	23	3532	1472	.0180	16				
			5-7.5		4.213	.0199		0.19	6	45	0.68	12	15	0.081	23	3539	1383	.0204	16		0.15		
			7.5-10		3.381	.02		0.16	6	33	1.04	11	9	0.383	21	2526	1798	.0202	3				
10-2		2/2-5/71	Suspended Sediment		2.949	.0145		0.33	13	67	1.21	20	26	0.024	40	4675	1562	.0147	10	66		297,000	
			0-2.5		3.651	.0131		0.40	11	55	0.82	12	13	0.012	27	4377	1369	.0136	312				
			2.5-5		4.653	.0282		0.24	5	45	0.79	13	11	0.013	26	3826	1313	.0286	161		0.14		
			5-7.5		3.947	.0178		0.16	5	45	0.74	11	14	0.086	24	3446	1454	.0181	<3				
			7.5-10		5.408	.0201		0.19	5	43	0.80	12	16	0.192	24	3976	1064	.0204	3				
11-2		2/2-5/71	Suspended Sediment		3.130	.0159		0.36	37	79	0.95	24	37	0.018	40	4288	1109	.0160	156	94		327,000	
			0-2.5		4.563	.0181		0.61	9	55	0.67	13	17	0.019	26	3717	1422	.0185	30				
			2.5-5		4.830	.0188		0.27	5	43	0.61	12	13	0.164	21	3780	1146	.0191	16		0.05		
			5-7.5		5.675	.0119		0.15	5	43	1.09	10	12	0.550	23	5385	1366	.0125	7				
			7.5-10		7.082	.0377		0.31	6	50	0.89	15	13	0.402	29	4538	2045	.0384	19				
12-2		2/2-5/71	Suspended Sediment		1.931	.0151		0.44	17	89	0.99	26	30	0.003	41	4580	1534	.0153	58	<10		292,000	
			0-2.5		4.760	.0128		0.56	14	85	0.67	27	19	0.055	20	4719	1895	.0130	280				
			2.5-5		5.093	.0250		0.20	7	56	0.94	13	19	0.163	17	3996	1938	.0253	12				
			7.5-10		7.222	.0306		0.31	8	70	1.25	15	29	0.209	22	4993	1835	.0310	32				
13-2		2/2-5/71	Suspended Sediment		3.188	.0156		0.30	37	93	0.97	23	35	0.004	52	5133	1518	.0157	15	<10		269,000	
			0-2.5		4.289	.0204		0.36	19	46	0.56	13	15	0.022	21	4256	1047	.0209	44				
			5-7.5		7.953	.0290		0.51	7	34	0.82	5	10	0.150	13	4157	1543	.0290	<4		0.16		
			10-12.5		6.703	.0325		0.59	8	68	0.83	13	23	0.068	26	5378	1293	.0330	<4				
14-2		2/2-5/71	Suspended Sediment		4.465	.0259		0.62	35	135	1.54	33	38	0.124	55	6602	1699	.0261	105	<10		201,000	
			0-2.5		4.953	.0144		0.30	15	114	0.64	31	24	0.007	22	5300	1129	.0150	24				
			5-7.5		4.835	.0232		0.19	8	32	0.78	7	7	0.007	14	4222	3652	.0244	17		0.15		
			10-12.5		9.953	.0488		0.15	4	62	0.81	18	20	0.180	22	4186	1137	.0497	75				
15-2		2/2-5/71	Suspended Sediment		4.484			0.43	31	97	1.01	22	34	0.097	39	5411	1656			<10		258,000	
			0-2.5		5.045	.0130		0.30	14	146	1.11	22	23	0.111	25	5020	2517	.0133	126				
			5-7.5		6.744	.0274		0.19	6	66	1.07	13	18	0.154	24	4175	1585	.0282	12		0.06		
			10-12.5		7.680	.0285		0.91	8	68	1.16	9	21	0.169	23	7601	1543	.0289	6				
16-2		2/2-5/71	Suspended Sediment		10.343	.0411		0.39	73	135	1.12	30	43	2.485	67	6192	2160	.0415	754	<10		178,000	
			0-2.5		6.428	.0388		0.21	8	84	0.87	14	21	0.149	28	5429	1492	.0392	95				
			2.5-5		6.974	.0216		0.43	9	66	1.34	9	21	0.141	33	4388	1814	.0219	55		0.05		
			7.5-10		6.200	.0395		0.35	6	61	1.43	9	23	0.348	37	5309	1632	.0398	4				
17-2		2/2-5/71	Suspended Sediment		4.311	.0124		0.24	58	100	0.61	19	38	1.025	52	2940	1177	.0129	306	<10		330,000	
			0-2.5																				
			2.5-5		9.330	.0407		0.71	41	195	1.35	26	25	3.57	39	5269	2003	.0415	464		0.13		
			5-7.5		8.018	.0919		0.97	31	218	1.52	32	26	0.015	46	2513	2049	.0923	805				
			7.5-10		7.060	.0754		0.53	25	123	1.53	30	27	0.031	44	3329	3329	.0758	1130				
18-2		2/2-5/71	Suspended Sediment		1.827			0.78	38	111	0.47	30	35	0.004	47	1878	1699		115	<10	0.21	234,000	
			0-2.5		4.674	.0145		0.13	5	47	0.79	8	20	0.122	29	3353	1431	.0149	10		0.10		
			2.5-5		4.948	.0219		0.39	13	77	1.55	15	21	0.002	27	4499	1734	.0221	21		0.19		
			5-7.5		4.570	.0216		0.19	5	43	0.33	4	18	0.142	32	3364	1583	.0221	<3		0.05		
19-2	San Francisco	12/28/70			0.17	0.013	0.1	0.08	4.79	3.78													
20-2	Main Ship Channel	4/5/71	SURF.	2.1	0.68	0.022	0.1	14.2	48.6														
21-2		4/5/71	SURF.	3.9	2.6	0.062	0.1	0.03	27.2	79													
22-2		4/5/71	SURF.	1.4	0.5	0.012	0.1	0.01	12.2	34.5													
23-2		6/8/71		1.19	0.16	0.017		0.03	13	55													
24-2		1/18/72	SURF.	1.3	0.33	0.01	0.04	0.005	6.3	27													
25-2		1/18/72	SURF.	1.0	0.17	0.01	0.03	0.002	1.2	18													
26-2		1/18/72	SURF.	1.3	0.36	0.01	0.01	0.01	8.8	31													
27-2	Alameda Naval Air Station - Turning Basin	2/24/71	SURF.	8.41	3.37	0.192		0.76	56	143	1.24	46	32	.031	48	4545	2372	.192	17	8	<0.08		D
28-2	Berthing Area	2/24/71	SURF.	8.80	4.90	0.278		1.27	71	236	1.30	49	33	.011	46	4477	2329	.2817	16	6	<0.08		D
29-2	Berthing Area	7/72	0-.5	9.0	6.90	0.29	.09	0.58	63	180	1.5	67											D
			3-3.5	9.1	6.70	0.35	.17	0.51	66	172	1.4	66											D

D: Detected

REPORTED AS % OF DRY WEIGHT

INDEX NO.	Location	Date	Depth	V.S.	COD	TKN	OIL & GREASE	Hg x10^{-4}	Pb x10^{-4}	Zn x10^{-4}	Cd x10^{-4}	Cu x10^{-4}	Cr x10^{-4}	As x10^{-4}	Ni x10^{-4}	SO_4 x10^{-4}	PO_4 x10^{-4}	N	S x10^{-4}	BOD mg/1	CN x10^{-4}	SS mg/1	PEST x10^{-7}
30-2	Berthing Area	7/72	0-.5	8.4	6.80	0.25	.12	0.97	62	160	1.1	59											D
			3-3.5	9.0	6.30	0.23	.11	0.46	63	160													
31-2	Berthing Area	7/72	0-.5	8.8	6.20	0.24	.15	0.60	60	179	0.95	67											D
32-2	Berthing Area	7/72	0-.5	9.3	7.00	0.28	.11	0.19	66	160	0.91	60											D
	" "		3-3.5	8.3	7.40	0.21	.11	0.59	87	192													
33-2	Berthing Area	7/72	0-.5	7.9	6.90	0.06	.11	0.67	66	163	0.76	66											D
	" "		3-3.5	8.1	6.00	0.05	.10	0.58	97	158													
34-2	Turning Basin	7/72	SURF.	9.1	5.70	0.18	.088	0.48	64	166	1.3	67											D
35-2	Turning Basin	7/72	0-.5	8.8	7.90	0.29	.11	0.52	56	149	1.10	58											D
	" "		3-3.5	9.3	7.10	0.19	.11	0.41	51	149													
	" "		6-6.5	8.6	6.30	0.14	.12	0.49	54	133													
36-2	Turning Basin	7/72	0-.5	7.6	8.10	0.23	.095	0.45	64	166	0.71	64											D
	" "		3-3.5	5.4	4.80	0.14	.046	0.43	38	128													
37-2	Turning Basin	7/72	0-.5	8.1	7.10	0.14	.083	0.48	55	142	0.66	54											D
38-2	Turning Basin	7/72	0-.5	8.9	7.60	0.17	.078	0.51	54	133	0.61	52											D
	" "		3-3.5	4.2	4.60	0.13	.055	0.45	27	82													
39-2	Turning Basin	7/72	0-.5	7.6	7.90	0.21	.083	0.55	49	124	0.48	44											D
40-2	Turning Basin	7/72	0-.5	8.4	7.50	0.18	.059	0.63	58	149	1.3	56											D
	" "		3-3.5	8.1	7.40	0.15	.042	0.42	54	130													
41-2	Site #1	7/72	0-.75	3.9		0.08		10	21	62		22											
	" "		.75-1.5	3.6		0.07		10	48	63		24											
42-2	Site #2	7/72	0-.5	8.3		0.20		10	32	121		43											
	" "		.5-2	7.6		0.18		10	36	173		52											
	" "		2-3.5	7.9		0.18		10	39	100	2.0	50											
43-2	Berthing Area	5/73	0-.5	8.2	5.3	0.14	.22	0.46	71	160	2.4	65											D
	" "		3-3.5	8.1	5.2	0.13	.23	0.76	69	160													
	" "		6-6.5	6.7	4.9	0.11	.18	1.1	67	160													
	" "		9-9.5	6.5	5.0	0.14	.20	1.4	130	140													
	" "		12-12.5	3.2	1.3	0.01	.014	0.14	11	26													
44-2	Berthing Area	5/73	0-.5	12.0	8.7	0.12	.55	1.3	150	380													D
	" "		3-3.5	9.1	6.7	0.08	.46	1.3	102	240													
			6-6.5	8.0	5.0	0.08	.24	1.4	98	180													
			9-9.5	7.3	4.4	0.07	.21	1.2	63	180													
			12-12.5	6.4	3.4	0.06	.23	0.79	50	190													
45-2	Berthing Area	5/73	0-.5	8.0	5.3	0.06	.14	0.82	70	180	3.0	59											D
			3-3.5	8.2	4.9	0.14	.11	0.72	64	150													
			6-6.5	6.4	5.2	0.24	.06	0.91	64	140													
			9-9.5	6.3	4.9	0.29	.1	0.73	80	160													
46-2	Berthing Area	5/73	0-.5	8.0	5.2	0.23	.15	0.69	70	150	3.0	47											D
			3-3.5	6.0	4.2	0.26	.12	0.73	70	140													
			6-6.5	7.2	8.2	0.05	.073	0.08	14	24													
47-2	Turning Basin	5/73	0-.5	8.0	4.1	0.32	.064	0.42	57	140	3.4	45											D
			3.3.5	5.3	4.5	0.18	.14	0.52	26	38													
			6-6.5	6.2	4.7	0.21	.13	0.71	8	19													
48-2	Turning Basin	5/73	0-.5	8.9	4.3	0.18	.076	0.60	66	140	2.3	43											D
			3-3.5	4.5	4.4	0.15	.18	0.54	64	150													
			6-6.5	5.3	3.0	0.11	.076	0.48	48	94													
			9-9.5	1.2	0.82	0.96	.023	0.10	7.9	21													
49-2	Turning Basin	5/73	0-.5	6.3	4.7	0.06	.23	0.94	110	260	3.1	79											D
			3-3.5	6.0	4.3	0.19	.15	0.60	60														
			6-6.5	6.3	4.9	0.16	.12	0.83	90	90													
			9-9.5	0.96	4.4	0.005	.012	0.11	5.8	16													
50-2	Ship Channel	5/73	0-.5	6.0	4.3	0.16	.063	0.80	71	170	2.0	50											D
			3-3.5	6.2	4.2	0.10	.069	0.68	54	120													
			6-6.5	6.4	2.8	0.13	.059	0.92	43	110													
			9-9.5	7.9	1.8	0.01	.067	0.09	5.3	22													
51-2	Ship Channel	5/73	0-.5	5.8	3.4	0.05	.079	0.54	50	110	1.7	36											D
			3-3.5	5.9	3.1	0.05	.092	0.71	53	110													
			6-6.5	2.2	7.7	0.02	.082	0.18	11	41													
52-2	Ship Channel	5/73	0-.5	7.5	3.6	0.06	.086	0.63	58	130	0.83	46											D
			3-3.5	6.4	3.1	0.13	.078	0.72	50	120													
			6-6.5	2.9	1.7	0.03	.091	0.14	14	34													
			9-9.5	2.9	1.6	0.01	.062	0.31	14	43													

D:Detected

REPORTED AS % OF DRY WEIGHT

Index NO.	Location	DATE	DEPTH	V.S.	COD	TKN	GREASE	Hg $x10^{-4}$	Pb $x10^{-4}$	Zn $x10^{-4}$	Cd $x10^{-4}$	Cu $x10^{-4}$	Cr $x10^{-4}$	As $x10^{-4}$	Ni $x10^{-4}$	SO_4 $x10^{-4}$	PO_4 $x10^{-4}$	TN	S $x10^{-4}$	BOD mg/l	CN $x10^{-4}$	BOD mg/l	PEST $x10^{-7}$
153-2	NAS Alameda	8/5/74	ELUT. 0-2.5 Sediment			.00032	0.22	0.5	12	120	0.6						.00036			6.9			D
			ELUT. 2.5-5.0 Sediment			.00024	0.30	0.5	21	110	0.7						.00027			6.1			D
			ELUT. 5-7.5 Sediment			.000168	0.24	0.6	24	86	2.5						.00172			8.4			D
			ELUT. 7.5-10 Sediment			.00058	0.380	1.2	20	130	2.4						.00061			4.8			D
154-2		8/5/74	ELUT. 0-2.5 Sediment			.00034	0.25	1.0	12	120	0.8						.00036			3.0			D
			ELUT. 2.5-5 Sediment			.00183	0.26	0.4	12	110	1.2						.00219			9.4			D
155-2		8/5/74	ELUT. 0-2.5 Sediment			.00224	0.15	0.2	14	130	0.8						.00228			12.0			D
			ELUT. 2.5-5 Sediment			.00068	0.27	0.2	12	62	1.8						.00072			7.8			D
			ELUT. 5-7.5 Sediment			.00241	0.15	0.8	12	58	1.9						.00248			5.1			D
156-2		8/5/74	ELUT. 0-2.5 Sediment			.00125	0.11	0.4	11	60	1.1						.00128			10.6			D
157-2		8/5/74	ELUT. 0-2.5 Sediment			.00144	0.22	0.6	13	150	1.8						.00147			7.2			D
			ELUT. 2.5-5 Sediment			.00172	0.23	0.2	15	130	2.5						.00177			9.6			D
158-2		8/5/74	ELUT. 0-2.5 Sediment			.00195	0.09	0.7	12	100	3.4						.00199			13.5			D
			ELUT. 2.5-5 Sediment			.00142	0.19	0.6	13	100	1.6						.00148			5.8			D
159-2		8/5/74	ELUT. 0-2.5 Sediment			.00195	0.17	0.5	12	110	4.1						.00199			8.1			D
		8/5/74	ELUT. 2.5-5.0 Sediment			.0013	0.19	.2	9	120	3.8						.00135			11.7			D
160-2		8/5/74	ELUT. 0-2.5 Sediment			.00024	0.01	.1	15	84	1.8						.00031			3.9			D
161-2		8/5/74	ELUT. 0-2.5 Sediment			.00015	0.15	.4	16	82	4.2						.0002			2.7			D
162-2		8/5/74	Water			.000063											.000073			4.8			D
163-2		9/23/74	0.0-2.5					.45	50	140	1.4												
			2.5-5.0					.45	75	170	1.6												
			5.0-7.5					.55	72	170	2.7												
			7.5-10.0					.71	95	190	4.6												
164-2		9/23/74	0.0-2.5																				
			2.5-5.0					.62	73	190	3.2												
			5.0-7.5					.52	68	180	1.6												
165-2			0.0-2.5					.50	85	170	1.1												
			2.5-5.0					.59	69	170	1.2												
			5.0-7.5					.54	58	170	1.3												
53-2	Richmond Harbor	8/10/71	SURF.	6.0	4.1	0.13	0.06	0.34	45	114													
54-2		8/10/71	SURF.	8.0	5.3	0.19	0.07	0.44	42	139													
55-2		8/10/71	SURF.	7.9	5.3	0.18	0.06	0.46	54	138													
56-2		5/26/72	0-2.5	3.7	1.1	0.04	0.029	0.50	10	50													D
			2.5-5	4.2	1.5	0.05	0.006	0.40	10	40													D
			5-7.5	4.8	2.4	0.06	0.018	0.40	10	50													D
			8-10.5	4.6	2.0	0.07	0.01	0.10	10	40													D
			13.5-15.5	5.5	2.8	0.09	0.044	0.02	10	60													D
			15.5-18.5	5.1	2.9	0.06	0.005	0.1	10	50													D
			21-23.5	6.6	3.4	0.10	0.005	0.3	10	60													D
			23.5-26	8.6	4.5	0.11	0.034	0.1	10	70													D
57-2		5/22/72	0-2.5	5.0	3.9	0.11	0.04	0.1	20	100													D
			5-6.3	4.1	4.2	0.10	0.01	0.1	10	40													D
			10-11.5	6.3	4.7	0.10	0.01	0.1	10	20													D
			15-16.3	7.0	4.8	0.10	0.01	0.03	10	70													D
			20-21.5	3.9	4.3	0.09	0.02	0.05	20	60													D
			25-26.3	3.1	3.2	0.05	0.01	0.08	10	30													D
			32.5-34.5	6.6	3.8	0.09	0.008	0.07	10	60													D
			37.5-39	5.8	1.7	0.07	0.02	0.07	10	60													D
58-2		5/19/72	0-2.5	6.3	9.1	0.19	0.21	0.6	80	240													D
			11.5-14	6.1	10.0	0.19	0.02	1.0	10	80													D
			23.4-25.5	1.1	1.0	0.08	0.007	0.3	10	30													D
59-2		5/23/72	0-2.5	4.1	2.2	0.06	0.03	0.1	20	80													D
			22.5-25	6.9	5.5	0.11	0.006	0.4	10	70													D
			41-41.5	8.0	3.3	0.04	0.005	0.9	10	80													D
60-2		7/21/71		2.7	1.4	0.035	0.01	0.19	14	56													
61-2		7/21/71		4.3	2.5	0.056	0.006	0.03	17	55													
62-2		7/21/71		4.3	2.3	0.047	0.003	0.1	19	56													

D: Detected

REPORTED AS % OF DRY WEIGHT

Index No.	LOCATION	DATE	DEPTH	VS	COD	TKN	OIL & GREASE	Hg x10-4	Pb x10-4	Zn x10-4	Cd x10-4	Cu x10-4	Cr x10-4	As x10-4	Ni x10-4	SO4 x10-4	PO4 x10-4	N x10-4	S x10-4	BOD mg/1	CN x10-4	S.S. mg/1	PEST x10-7
63-2	Richmond Harbor	8/14/72	0-.5	7.6	5.39	0.25	.091	0.486	153	152	0.84	58											
			1-4	6.3	5.3	0.17	.071	0.435	36	97	0.76	51											
64-2		8/14/72	0-1	7.0	5.18	0.16	.076	0.465	45	107	0.84	52											
65-2		8/14/72	0-.5	7.4	4.29	0.21	.065	0.387	39	111	0.84	56											
			3-6	6.9	4.58	0.18	.081	0.753	46	116	0.71	56											
			8.5-10.5	5.8	3.82	0.17	.091	0.472	37	101	0.97	53											
66-2		8/14/72	0-.5	7.5	4.33	0.16	.043	0.457	40	100	0.79	45											
			4-6	7.1	4.95	0.17	.074	0.581	43	115	1.03	52											
67-2		8/14/72	0-.5	7.0	5.2	0.18	.066	0.434	47	100	0.79	55											
			8.5-11.9	7.2	4.57	0.19	.072	0.526	46	110	0.66	57											
			10.75-14	6.2	4.48	0.16	.091	0.688	39	91	0.67	46											
68-2		8/14/72	0-.5	7.4	4.73	0.24	.052	0.464	40	104	0.80	55											
			2-6	7.4	4.28	0.20	.074	0.523	44	107	0.57	53											
69-2		9/12/72	0-.5	9.2	7.95	0.03	.600	1.94	150	549	1.5	97											D
			.5-2	8.5	6.63	0.02	.352	1.41	131	476	1.4	77											D
			2-3.5	7.5	6.72	0.02	.374	1.63	112	326	2.0	67											D
70-2		9/25/72	0-.75	7.5	4.3	0.15	.14	0.8	50	198	2.6	84	123	0.7	139				420				D
			.75-1.5	6.0	2.6	0.11	.06	1.0	27	134	3.4	59	93	0.7	108				180				D
71-2		9/25/72	0-.75	7.8	4.2	0.15	.01	0.5	50	185	1.6	77	137	1.2	138				327				D
			.75-1.5	7.4	4.2	0.15	.11	0.5	37	168	1.9	70	114	1.1	125				226				D
72-2		9/25/72	0-.75	8.3	5.0	0.17	.11	0.6	30	143	2.1	65	135	0.9	110				537				D
			.75-1.5	8.3	5.0	0.18	.01	0.7	39	219	1.9	89	140	0.9	147				930				D
73-2		9/25/72	0-.75	7.5	4.4	0.15	.08	1.0	35	148	1.8	60	117	2.1	118				582				D
			.75-1.5	6.7	4.2	0.14	.07	0.4	32	138	1.6	54	120	1.2	114				172				D
74-2		9/25/72	0-.75	5.2	4.4	0.09	.01	0.2	14	74	1.4	33	91	1.2	97				19				D
			.75-1.5	6.4	4.1	0.13	.04	0.5	39	134	1.6	50	130	1.9	111				104				D
75-2		9/25/72	0-.75	3.8	2.8	0.07	.02	0.1	12	58	1.2	21	67	1.0	75				6				D
			.75-1.5	4.4	3.7	0.09	.01	0.1	6	66	1.0	22	86	0.8	97				2				D
166-2		6/74	Water			.0001												.00010		1.8		74	D
167-2		6/74	ELUT. 0.0-2.5			.0007												.0007		0.8		111	D
			Sed.			.047	.047	0.4	20	66	0.5	22											
			ELUT. 2.5-5.0			.0009												.0009		1.4		96	D
			Sed.				.0078	0.3	27	66	0.5	19											
			ELUT. 5.0-7.5			.0012												.0012		1.6		229	D
			Sed.				.0089	1.1	19	63	0.5	21											
168-2		6/74	ELUT. 0.0-2.5			.0011												.0011		4.2		102	D
			Sed.				.0944	1.7	54	135	0.6	63											
			ELUT. 2.5-5.0			.0008												.0008		6.4		310	D
			Sed.				.0677	1.1	56	133	0.7	64											
			ELUT. 5.0-10.0			.0018												.0018		5.8		260	D
			Sed.				.0431	1.0	29	83	0.5	44											
			ELUT. 10.-15.0			.0020												.0020		14.2		260	D
			Sed.				.0706	0.8	26	77	0.6	45											
			ELUT. 15.0-19.8			.0020												.0020		4.8		81	D
			Sed.				.0561	0.5	25	75	0.6	41											
			ELUT. 20.0-24			.0018												.00181		6.8		160	D
			Sed.				.0396	0.7	27	84	0.5	35											
			ELUT. 25.0-29.2			.0018												.0018		8.2		56	D
			Sed.				.0445	0.8	24	72	0.5	33											
169-2		6/74	ELUT. 0.0-1.0			.0008												.0008		3.8		254	D
			Sed.				.0612	1.0	45	134	0.6	59											
			ELUT. 2.5-7.5			.0015												.0015		6.6		123	D
			Sed.				.0683	1.5	38	131	0.6	55											
			ELUT. 7.5-12.5			.0015												.0015		4.6		179	D
			Sed.				.0690	0.9	41	120	0.6	53											
170-2		6/74	ELUT 0.0-2.5			.0011												.0011		4.8		220	D
			Sed.				.0483	0.8	36	98	0.4	43											
			ELUT. 2.5-5.0			.0014												.0014		2.8		249	D
			Sed.				.0587	0.8	30	89	0.4	40											

D:Detected

REPORTED AS % OF DRY WEIGHT

Index No.	LOCATION	DATE	DEPTH	V.S.	COD	TKN	Oil & GREASE	Hg x10-4	Pb x10-4	Zn x10-4	Cd x10-4	Cu x10-4	Cr x10-4	As x10-4	Ni x10-4	SO_4 x10-4	PO_4 x10-4	N	S x10-4	BOD mg/l	CN x10-4	S.S. mg/l	PEST x10-7
171-2	Richmond Harbor	6/74	ELUT. 0.0-2.5			.0004												.0004		1.6		99	D
			Sed.				.0097	0.3	17	48	0.5	16											
			ELUT. 2.5-6.6			.0010												.0010		2.4		34	D
			Sed.				.0124	0.4	16	52	0.6	18											
			ELUT. 7.5-12.5			.0018												.0018		2.0		66	D
			Sed.				.0064	0.5	15	64	0.6	25											
172-2		6/74	ELUT. 0.0-1.5			.0004												.0004		1.6		157	D
			Sed.				.0044	0.4	14	63	0.5	16											
			ELUT. 2.5-3.8			.0005												.0005		1.2		280	D
			Sed.				.0229	0.5	14	70	0.4	27											
			ELUT. 5.0-7.3			.0009												.0009		2.8		196	D
			Sed.				.0167	0.6	12	52	0.4	20											
			ELUT. 7.5-10.0			.0008												.0008		1.0		149	D
			Sed.				.0137	0.4	9	48	0.3	17											
173-2		6/74	ELUT. 0.0-2.5			.0003												.0003		1.6		184	D
			Sed.				.0130	0.4	19	54	0.6	27											
			ELUT. 2.5-5.0			.0005												.0005		1.4		69	D
			Sed.				.0111	0.3	15	42	0.7	15											
			FLUT. 5.0-7.5			.0003												.0003		1.8		42	D
			Sed.				.004	0.4	17	40	0.6	16											
			ELUT. 7.5-8.9			.0008												.0008		0.4		29	D
			Sed.				.0057	0.3	21	46	0.8	22											
174-2		6/74	ELUT 0.0-2.5			.0015												.0015		3.8		403	D
			Sed.				.0542	0.5	43	104	0.6	68											
			FLUT. 2.5-7.5			.0013												.0013		5.8		227	D
			Sed.				.0433	0.5	19	92	0.8	53											
			FLUT. 7.5-12.1			.0005												.0005		4.8		249	D
			Sed.				.0302	0.8	24	65	0.6	45											
175-2		6/74	FLUT. 0.0-2.5			.0006												.0006		6.4		80	D
			Sed.				.0418	0.8	29	38	0.8	62											
			ELUT. 2.5-5.0			.0015												.0015		2.2		160	D
			Sed.				.0109	0.6	12	91	0.7	64											
			ELUT. 5.0-9.7			.0013												.0013		9.0		158	D
			Sed.				.0148	0.5	12	78	0.5	52											
176-2		6/74	ELUT 0.0-2.5			.0012												.0012		3.6		323	D
			Sed.				.0507	0.6	40	100	0.6	57											
			ELUT. 2.5-5.0			.0014												.0014		3.8		120	D
			Sed.				.0477	0.9	27	104	0.5	60											
			ELUT. 5.0-7.5			.0014												.0014		4.6		242	D
			Sed.				.0467	0.6	25	81	0.8	53											
177-2		6/74	ELUT. 0.0-2.5			.0004												.0004		3.2		289	D
			Sed.				.0361	0.4	30	79	0.6	48											
			ELUT. 2.5-5.0			.0006												.0006		4.2		81	D
			Sed.				.0104	0.6	16	58	0.7	32											
			ELUT. 5.0-7.5			.0006												.0006		1.2		127	D
			Sed.				.0079	0.7	19	70	1.0	34											
			ELUT. 7.5-10.0			.0010												.0010		0.8		119	D
			Sed.				.015	0.5	22	74	0.6	42											
			ELUT. 10.0-12.5			.0012												.0012		2.2		239	D
			Sed.				.0079	0.6	17	80	0.8	43											
178-2		6/74	ELUT 0.0-2.5			.0008												.0008		0.6		81	D
			Sed.				.0028	0.4	18	50	0.8	27											
			ELUT. 2.5-5.0			.0007												.0007		1.2		24	D
			Sed.				.0007	0.4	17	52	0.7	24											
			ELUT. 5.0-7.5			.0009												.0009		1.0		39	D
			Sed.				.0035	0.5	14	51	0.6	23											
179-2		6/74	ELUT. 0.0-2.5			.0010												.0010		1.4		72	D
			Sed.				.0085	0.4	19	52	0.5	21											
			ELUT. 2.5-6.4			.0008												.0008		2.2		145	D
			Sed.				.0251	0.7	12	50	0.7	29											
			ELUT. 6.4-10.4			.0003												.0003		2.6		280	D
			Sed. 6.4-10.4				.0124	0.6	17	59	0.8	31											

D: Detected

REPORTED AS % DRY WEIGHT

Index No.	LOCATION	DATE	DEPTH	V.S.	COD	TKN	Oil & GREASE	Hg x10-4	Pb x10-4	Zn x10-4	Cd x10-4	Cu x10-4	Cr x10-4	As x10-4	Ni x10-4	SO_4 x10-4	PO_4 x10-4	N	S x10-4	BOD mg/1	CN x10-4	S.S. mg/1	PEST x10-7
180-2	RICHMOND HARBOR	6/74	ELUT. 0.0-2.5 Sed.			.0001	.019	0.8	30	74	0.7	26						.0001		2.2		116	D
			ELUT. 2.5-5.0 Sed.			.0005	.008	0.7	14	59	0.7	24						.0005		1.8		276	D
			ELUT. 5.0-10.0 Sed.			.0008	.0178	0.6	14	66	0.7	34						.0008		3.6		235	D
181-2		6/74	ELUT. 0.0-2.5 Sed.			.0011	.0401	0.6	37	85	0.8	40						.0011		5.2		76	D
			ELUT. 2.5-5.0 Sed.			.0010	.0444	0.4	30	98	0.7	47						.0010		4.2		105	D
			ELUT. 5.0-10.0 Sed.			.0008	.0392	0.5	24	90	0.6	37						.0008		4.2		178	D
			ELUT. 10.0-15.0 Sed.			.0006	.0159	0.7	14	69	0.5	32						.0006		1.2		97	D
182-2		6/74	ELUT. 0.0-2.5 Sed.			.0005	.0404	0.6	32	89	0.8	40						.0005		2.6		207	D
			ELUT. 2.5-5.0 Sed.			.0010	.0583	0.5	36	106	0.8	52						.0010		5.6		103	D
			ELUT. 5.0-10.0 Sed.			.0011	.0176	0.7	12	74	0.7	33						.0011		5.8		111	D
			ELUT. 10.0-15.0 Sed.			.0014	.0257	0.5	14	72	0.9	36						.0014		0.4		258	D
183-2		6/74	ELUT. 0.0-2.5 Sed.			.0011	.0381	0.5	14	78	0.6	35						.0011		4.2		179	D
			ELUT. 2.5-5.0 Sed.			.0008	.0491	0.4	21	83	0.6	35						.0008		2.2		393	D
			ELUT. 5.0-7.5 Sed.			.0007	.0111	0.5	12	67	0.6	30						.0007		2.0		132	D
			ELUT. 7.5-12.5 Sed.			.0004	.0122	0.3	11	70	0.5	31						.0004		4.2		219	D
184-2		7/10/74	ELUT. 0-2.5 Sed.			.000504	.2090	.515	19.9	83.4	<2.0							.00053		6.0		433	D
		8/74	ELUT. 2.5-4.0 Sed.			.00015	.0105	0.2	12	45	1.0	29						.00029		2.0		107	
185-2		7/10/74	ELUT. 0-2.5 Sed.			.00073	.2220	.670	32.9	113	<2.0							.00075		7.5		140	D
		8/74	ELUT. 2.5-5 Sed.			.00027	.0108	0.6	16.0	54	0.9	37						.0004		6.6		197	
			ELUT. 5.0-7.5 Sed.			.00016	.0123	0.3	9.0	38	1.1	26						.00026		0.6		358	
			ELUT. 7.5-10.0 Sed.			.00013	.0095	0.3	7.0	31	0.7	21						.00028		0.6		165	
186-2		7/10/74	ELUT. 0-1.5 Sed.			.00045	.1610	.537	32.3	120	<2.0							.00048		8.9		120	D
		8/74	ELUT. 1.5-2.0 Sed.			.00034	.0358	0.5	19	55	1.1	44						.00047		3.6		46	
187-2		7/10/74	ELUT. 0-1.5 Sed.			.000476	.1340	.639	32.5	51.1	<2.0							.00049		7.6		175	D
		8/74	ELUT. 1.5-4.0 Sed.			.00184	.0737	0.5	69.0	152.0	1.6	77						.00198		6.4		388	
			ELUT. 4.0-6.0 Sed.			.00107	.0842	0.3	32.0	90.0	1.1	35						.00121		3.8		541	
			ELUT. 6.5-8.2 Sed.			.00026	.0104	0.3	16.0	55	0.8	20						.00036		0.4		301	
			ELUT. 9.0-10.9 Sed.			.00026	.0104	0.3	16.0	55	0.8	20						.00036		0.4		301	
188-2		7/10/74	ELUT. 0-2.5 Sed.			.000476	.15	.963	27.2	63.4	<2.0							.000485		4.7		130	D
		8/74	ELUT. 2.5-4.5 Sed.			.00199	.1218	0.4	69.0	134	1.7	104						.0021		4.6		385	
			ELUT. 5.0-7.2 Sed.			.00093	.0314	0.4	27	62	1.0	55						.00109		6.0		395	
			ELUT. 7.5-10 Sed.			.00031	.0013	0.5	16	46	1.2	54						.00036		2.8		408	
			ELUT. 10.0-12.0 Sed.			.00045	.0115	0.3	17	51	1.0	45						.00057		1.0		410	

D: Detected

REPORTED AS % OF DRY WEIGHT

Index No.	LOCATION	DATE	DEPTH	VS	COD	TKN	OIL & GREASE	Hg x10-4	Pb x10-4	Zn x10-4	Cd x10-4	Cu x10-4	Cr x10-4	As x10-4	Ni x10-4	SO_4 x10-4	PO_4 x10-4	N	S x10-4	BOD mg/1	CN^- x10-4	S.S. mg/1	PEST x10/7
189-2	RICHMOND HARBOR	7/10/74	ELUT. 0-2.5 Sed.			.000756	.1760	0.659	25.0	110	<2.0							.00078		5.5		118	D
		8/74	ELUT. 2.5-4.7 Sed.			.00146	.1222	0.8	52	138	1.7	82						.0016		2.4		139	
			ELUT. 5.0-7.0 Sed.			.00197	.1320	0.7	57	130	1.9	95						.0021		11.0		134	
			ELUT. 7.5-10 Sed.			.00248	.0968	0.8	46	112	1.7	80						.0026		12.4		187	
			ELUT. 10-12.5 Sed.			.00254	.0272	0.3	17	72	1.3	61						.00265		7.0		174	
			ELUT. 12.5-15.0 Sed.			.0029	.0157	0.3	15	58	1.0	45						.00298		12.0		89	
190-2		8/74	ELUT. 0-2.5 Sed.			.00037	.0250	0.4	19	58	1.2	43						.0005		11.6		129	
			ELUT. 2.5-5.0 Sed.			.00105	.0413	0.3	17	44	1.1	31						.0012		2.8		129	
			ELUT. 5.0-7.5 Sed.			.00132	.0150	0.4	14	51	1.0	23						.00145		3.0		151	
			ELUT. 7.5-10.0 Sed.			.00152	.0239	0.4	17	54	1.1	32						.00166		4.0		61	
			ELUT. 10.0-12.5 Sed.			.00175	.0161	0.4	12	47	1.0	34						.0019		1.0		138	
			ELUT. 12.5-15.0 Sed.			.00213	.0132	0.5	12	42	1.0	31						.00227		1.6		242	
			ELUT. 15-17.5 Sed.			.00235	.0397	0.4	13	47	0.7	28						.0025		4.6		102	
			ELUT. 15.5-20.0 Sed.			.00263	.0720	0.6	14	47	1.0	26						.00277		4.2		204	
191-2		7/10/74	ELUT. 0-2.0 Sed.			.000644	.0970	0.385	27.4	93.1	<2.0							.00066		10.3		208	D
		8.74	ELUT. 2.0-4.0 Sed.			.00161	.1293	0.6	44	92	1.5	40						.00176		5.0		151	
			ELUT. 4.0-6.5 Sed.			.00254	.0682	0.7	29	78	1.4	46						.00269		11.6		720	
			ELUT. 6.5-8.7 Sed.			.00297	.0323	0.4	20	63	1.1	43						.0030		6.0		268	
			ELUT. 9.0-11.5 Sed.			.00302	.0324	0.5	14	59	1.1	56						.0031		2.8		356	
192-2		7/10/74	ELUT. 0-2.5 Sed.			.000588	.1030	0.311	17.3	60.6	<2.0							.00061		5.2		130	D
		8/74	ELUT. 2.5-5.0 Sed.			.00118	.0167	0.5	27	62	0.9	28						.0013		2.4		387	
			ELUT. 5.0-7.5 Sed.			.00143	.0069	0.5	28	76	0.9	46						.00158		4.2		279	
193-2		7/10/74	ELUT. 0-2.5 Sed.			.00076	.0840	0.402	23.1	78.4	22.0							.00078		6.2		160	D
		8/74	ELUT. 2.5-5.0 Sed.			.00141	.0572	0.5	27	59	1.1	31						.00158		5.6		314	
			ELUT. 5.0-7.5 Sed.			.00193	.0320	0.3	23	74	1.0	45						.00207		3.2		502	
194-2		7/10/74	ELUT. 0-2.5 Sed.			.0007	.1180	0.370	23.2	88.3	<2.0							.00073		4.7		140	D
		8/74	ELUT. 2.5-5 Sed.			.00128	.0730	0.4	42	75	1.0	63						.0014		.2		114	
			ELUT. 5-7.5 Sed.			.00147	.0254	0.6	27	73	1.3	45						.00162		3.4		149	
			ELUT. 7.5-10.0 Sed.			.00164	.0406	0.3	26	81	1.0	46						.00179		2.0		180	
195-2		8/74	ELUT. 0-1 Sed.			.00115	.0148	0.4	24	58	1.0	23						.0013		5.0		149	
			ELUT. 1-3.5 Sed.			.00113	.0131	0.3	16	59	0.9	25						.00128		0.6		65	
			ELUT. 3.5-6.0 Sed.			.00127	.0121	0.3	14	64	1.0	30						.0014		0.8		119	
			ELUT. 6.0-8.5 Sed.			.00137	.0153	0.5	22	65	1.0	27						.0015		1.2		212	
196-2		8/74	ELUT. 0-2.5 Sed.			.00123	.0204	0.5	20	60	0.7	24						.00131		1.8		101	
			ELUT. 2.5-5.0 Sed.			.00121	.003	0.4	17	58	0.6	25						.00137		1.8		108	

D: Detected

REPORTED AS % OF DRY WEIGHT

Index No.	LOCATION	DATE	DEPTH	VS	COD	TKN	OIL & GREASE	Hg x10-4	Pb x10-4	Zn x10-4	Cd x10-4	Cu x10-4	Cr x10-4	As x10-4	Ni x10-4	SO4 x10-4	PO4 x10-4	N	S x10-4	BOD mg/l	CN x10-4	S.S. mg/l	PEST x10-7
197-2	RICHMOND HARBOR	8/74	ELUT. 0-1			.00028												.0004		3.6		322	
			Sed.				.0384	0.3	30	78	0.7	24											
			ELUT. 1-2.3			.00075												.0086		1.2		320	
			Sed.				.0114	0.4	21	54	0.6	19											
			ELUT. 2.5-5			.00108												.0012		2.0		250	
			Sed.				.0069	0.3	17	52	0.7	17											
			ELUT. 5-6.5			.00116												.0013		2.0		303	
			Sed.				.0096	0.4	22	50	0.7	18											
			ELUT. 6.5-8.8			.00116												.0013		2.0		303	
			Sed.				.0096	0.4	22	50	0.7	18											
			ELUT. 9-11			.00119												.0014		5.6		322	
			Sed.				.0067	0.4	15	43	0.6	13											
			ELUT. 11-13.5			.00151												.00165		3.0		341	
			Sed.				.0070	0.3	18	54	0.8	18											
			ELUT. 13.5-16			.00073												.00088		3.4		372	
			Sed.				.0093	0.5	15	72	1.0	23											
			ELUT. 16-18.5			.00284												.00299		6.0		416	
			Sed.				.0132	0.4	16	64	1.3	24											
198-2		7/10/74	WATER			<.00028												.00056		1.5		18	D
199-2		8/74	WATER			.00022												.00036		1.0		68	
77-2	Pt. Molate	2/24/74	SURF.		5.08	0.21		0.55	39	112	0.48	37	20.0	<.001	37	4336	2076	<0.2	<4		0.43		D
78-2		8/20/72	0-.5	7.4	3.02	0.25	0.08	0.45	40	140	0.76	52											D
			3.0-3.5	7.9	3.5	0.29	.075	0.49	44	140													D
79-2		8/30/72	0-.5	8.7	3.5	0.04	0.085	0.39	37	120	0.58	44											D
80-2		8/30/72	0-.5	7.3	3.0	0.10	.084	0.34	41	140	0.80	49											D
81-2		8/30/72	0-.5	7.0	3.3	0.28	.096	0.34	38	140	0.77	45											D
82-2		8/30/72	0-.5	7.6	3.3	0.19	.087	0.46	38	140	0.86	58											D
83-2		8/30/72	0-.5	7.2	3.1	0.18	.075	0.37	41	140	0.76	46											D
			3-3.5	8.0	3.3	0.12	.123	0.43	47	150													D
84-2		8/30/72	0-.5	6.9	2.9	0.086	.082	0.42	38	130	0.71	47											D
85-2		8/30/72	0-.5	7.4	2.9	0.007	.087	0.42	42	130	0.71	49											D
86-2		8/30/72	SURF.	8.1	2.8	0.015	.096	0.44	46	160	0.76	47											D
200-2		8/5/74	ELUT. 0.0-2.5			.00034												.00035		6.9			D
			Sed.				0.09	0.6	8	88	1.8												
			ELUT. 2.5-5.0			.00183												.00184		6.9			D
			Sed.				0.042	0.8	6	105	1.9												
			ELUT. 5.0-7.5			.00224												.00226		5.1			D
			Sed.				0.11	1.0	15	96	1.6												
201-2		8/5/74	ELUT. 0.5-2.5			.00068												.00071		3.1			D
			Sed.				0.12	0.9	16	80	1.2												
			ELUT. 2.5-5.0			.00144												.00144		2.7			D
			Sed.				0.078	0.8	20	150	1.7												
			ELUT. 5.0-7.5			.00199												.0020		9.3			D
			Sed.				0.065	0.3	18	140	1.2												
202-2		8/5/74	ELUT. 0.0-2.5			.00087												.0009		8.6			D
			Sed.				0.07	0.6	20	110	1.7												
			ELUT. 2.5-5.0			.00176												.00178		4.6			D
			Sed.				0.1	0.7	12	130	1.4												
			ELUT. 5.0-7.5			.00175												.00176		2.1			D
			Sed.				0.098	0.5	24	120	2.2												
			ELUT. 7.5-10.0			.00203												.00207		5.4			D
			Sed.				0.099	0.5	18	130	1.8												
203-2		8/5/74	ELUT 0.0-2.5			.00046												.00048		2.1			D
			Sed.				0.095	0.4	9	100	1.6												
			ELUT. 2.5-5.0			.00096												.0010		9.3			D
			Sed.				0.09	0.2	20	110	2.1												
			ELUT. 5.0-7.5			.0015												.0015		6.9			D
			Sed.				0.097	0.5	20	130	1.7												
			ELUT. 7.5-10.0			.00156												.00157		5.4			D
			Sed.				0.13	0.2	12	100	1.8												
			ELUT. 10.0-12.5			.00118												.00119		5.4			D
			Sed.				0.12	0.7	13	120	1.5												

D: Detected

Index No.	LOCATION	DATE	DEPTH	VS	COD	TKN	OIL & GREASE	Hg x10-4	Pb x10-4	Zn x10-4	Cd x10-4	Cu x10-4	Cr x10-4	As x10-4	Ni x10-4	SO_4 x10-4	PO_4 x10-4	N	S x10-4	BOD mg/l	CN x10-4	S.S. mg/l	PEST x10-7
(Cont'd)																							
204-2	Pt. Molate	8/5/74	ELUT. 0.0-2.5			.00024												.00025		14.4			D
			Sed.				.045	0.3	15	140	1.5												
			ELUT. 2.5-5.0			.00088												.0009		12.0			D
			Sed.				0.11	0.4	21	110	0.7												
			ELUT. 5.0-7.5			.00163												.00163		5.4			D
			Sed.				0.11	0.6	22	120	1.6												
			ELUT. 7.5-10.0			.00184												.00185		11.4			D
			Sed.				0.11	0.5	22	160	1.4												
205-2		8/5/74	ELUT 0.0-2.5			.00064												.00065		9.3			D
			Sed.				0.1	0.2	26	97	1.3												
			ELUT. 2.5-5.0			.00058												.00059		13.5			D
			Sed.				0.08	0.7	24	89	1.5												
			ELUT. 5.0-7.5			.0004												.00042		11.1			D
			Sed.				0.042	1.0	23	90	0.8												
			ELUT. 7.5-10.0			.00147												.00149		13.5			D
			Sed.				0.02	0.8	24	110	1.7												
			ELUT. 10.0-12.5			.00152												.00154		3.9			D
			Sed.				.01	0.2	24	100	1.6												
			ELUT. 12.5-15.0			.00168												.00170		5.7			D
			Sed.				0.085	0.2	18	110	1.7												
			ELUT. 15.0-17.5			.00216												.00218		6.9			D
			Sed.				0.11	0.4	23	88	1.5												
206-2		8/5/74	ELUT. 0.0-2.5			.00041												.00041		2.4			D
			Sed.				0.16	0.3	18	87	1.9												
			ELUT. 2.5-5.0			.0014												.00141		2.4			D
			Sed.				0.12	0.4	21	97	1.3												
			ELUT. 5.0-7.5			.00126												.00127		3.9			D
			Sed.				0.12	0.3	21	130	1.5												
			ELUT. 7.5-10.0			.00149												.00150		4.8			D
			Sed.				0.12	0.9	24	120	1.2												
87-2	NORTH SAN Francisco Bay	4/16/74	0-2.4	6.2	3.7	0.11	0.18	0.6	48	126													
			2.4-7.5	6.7	3.2	0.09	0.06	0.6	28	83													
			7.5-17.5	6.0	2.4	0.09	0.04	0.3	25	74													
			17.5-22.5	7.2	3.0	0.11	0.05	0.3	26	70													
			22.5-30	5.2	4.2	0.12	0.02	0.2	17	70													
			30-35	4.7	3.1	0.09	0.01	0.2	18	71													
88-2		4/19/73	0-2.4	6.9	4.6	0.14	0.06	0.4	61	126													
			2.4-9	6.2	3.9	0.11	0.05	0.5	39	81													
			9-17.5	6.3	2.8	0.10	0.04	0.4	36	67													
			17.5-25	6.7	3.0	0.11	0.05	0.3	24	61													
			25-32.5	5.4	3.8	0.09	0.01	0.1	24	64													
			32.5-37.5	4.9	4.4	0.10	0.01	0.1	23	82													
89-2		4/23/73	0-2.5	5.6	4.1	0.13	0.05	0.4	20	87													
			2.5-7.5	5.1	4.4	0.10	0.01	0.2	9	56													
			7.5-12.5	4.8	4.2	0.09	0.01	0.1	10	74													
90-2		4/23/73	0-2.5	5.9	3.5	0.12	0.03	0.4	22	109													
			2.5-7.5	5.0	3.6	0.10	0.01	0.2	16	77													
			7.5-10	4.9	4.0	0.10	0.02	0.1	9	57													
			10-12.5	5.8	4.0	0.13	0.03	0.2	10	64													
91-2		4/25/73	0-2	5.7	4.5	0.13	0.04	0.3	18	111													
			2-10	5.5	3.9	0.09	0.11	0.1	9	58													
			10-17.5	5.1	4.0	0.08	0.09	0.2	11	99													
92-2		4/25/73	0-2.5	7.5	4.4	0.16	0.09	0.7	32	218													
			2.5-7.5	5.3	4.3	0.11	0.04	0.4	27	52													
			7.5-12.5	5.3	3.8	0.09	0.02	0.2	22	103													
93-2		4/25/73	0-5	0.2	3.7	0.10	0.03	0.3	38	117													
			5-10	5.2	3.7	0.11	0.02	0.1	20	87													
			10-15	4.8	2.9	0.08	0.01	0.1	17	75													
94-2		4/27/73	0-5	3.3	27	0.06	0.01	0.1	16	64													
			5-10	5.2	4.4	0.10	0.01	0.1	17	81													
			10-12.5	4.1	2.7	0.08	0.02	0.2	17	71													
95-2		5/1/73	0-12.5	4.7	3.5	0.08	0.01	0.1	14	69													
			2.5-7.5	5.7	3.8	0.11	0.02	0.1	19	86													
			7.5-12.5	4.6	2.9	0.07	0.01	0.1	15	58													
96-2		5/1/73	0-5	4.9	3.6	0.10	0.02	0.2	18	75													
			5-10	4.9	4.8	0.11	0.07	0.1	14	71													
			10-12.5	5.0	4.3	0.11	0.01	0.1	17	68													
97-2		5/2/73	0-5	6.2	4.5	0.13	0.02	0.2	33	133													
			5-10	4.8	4.6	0.11	0.02	0.2	14	68													
98-2		5/3/73	0-2.5	0.4	3.1	0.10	0.05	0.4	31	93													
			2.5-5	5.4	4.8	0.13	0.02	0.2	17	75													
99-2		5/8/73	0-2.5	2.2	0.5	0.02	0.01	0.2	25	73													
			2.5-7.5	2.2	0.6	0.02	0.01	0.1	28	68													
			7.5-10	2.5	0.8	0.03	0.01	0.2	20	65													
100-2		5/9/73	0-2.5	3.5	0.8	0.02	0.01	0.2	20	53													
			2.5-7.5	3.2	3.1	0.003	0.01	0.1	13	39													
101-2		5/10/73	0-2.5	3.3	2.2	0.05	0.01	0.1	11	57													
			2.5-7.5	3.6	2.3	0.06	0.01	0.2	12	53													
102-2		5/10/73	0-2.5	3.7	2.4	0.05	0.01	0.1	17	49													
			2.5-7.5	4.2	4.5	0.05	0.01	0.1	14	60													
			7.5-10.0	4.4	4.4	0.04	0.01	0.1	13	48													

D:Detected

REPORTED AS % OF DRY WEIGHT

Index No.	LOCATION	DATE	DEPTH	V.S.	COD	TKN	OIL & GREASE	Hg x10-4	Pb x10-4	Zn x10-4	Cd x10-4	Cu x10-4	Cr x10-4	As x10-4	Ni x10-4	SO_4	PO_4 x10-4	N	S x10-4	BOD mg/1	CN x10-4	S.S. mg/1	PEST x10-7
103-2	OAKLAND	10/26/71	0-2.5	7.6	5.3	0.18	0.05	0.4	58	123													
104-2	OUTER		0-2.5	3.9	3.7	0.09	0.08	0.42	50	93													
105-2	HARBOR	11/29/71	0-2.5	2.8	1.42	0.10	0.07	0.08	51	161													
106-2			0-2.5	7.2	4.95	0.21	0.10	0.13	140	361													
107-2			0-2.5	5.6	3.43	0.27	0.09	0.29	95	293													
108-2			0-2.5	4.9	4.26	0.19	0.15	0.17	152	405													
109-2			0-2.5	8.1	5.41	0.26	0.16	0.07	157	300													
110-2			0-2.5	6.9	5.07	0.18	0.16	0.06	172	279													
111-2			0-2.5	10.5	6.72	0.23	0.46	0.22	224	361													
112-2			0-2.5	8.9	5.67	0.15	0.32	0.16	163	393													
113-2		11/72	.75-1	6.1	3.8	0.12	0.15	0.6	37	104	1.2	48	57	0.5	110				330				
			0-7.5	8.4	5.2	0.18	0.15	0.1	61	174	1.8	85	73	0.5	133				1015				
114-2			.75-1.5	8.1	5.0	0.18	0.14	0.4	55	118	1.6	53	65	0.5	130				644				
			0-.75	8.6	4.9	0.18	0.12	0.3	55	173	1.3	55	68	1.0	162				588				
115-2			.75-1.5	8.0	4.7	0.17	0.10	0.4	46	151	1.2	42	59	0.7	122				422				
			0-.75	8.4	5.2	0.18	0.10	0.1	57	181	1.1	67	71	0.9	139				795				
116-2			.75-1.5	4.5	2.3	0.09	0.07	0.8	31	109	0.5	34	49	1.3	104				358				
			0-.75	5.9	3.4	0.12	0.10	0.2	46	152	1.2	58	61	0.9	134				436				
117-2			.75-1.5	4.6	3.1	0.10	0.09	0.1	33	106	0.8	37	50	1.1	81				250				
			0-.75	5.1	3.1	0.11	0.05	0.1	33	124	0.7	34	49	0.8	77				413				
118-2			.75-1.5	4.0	2.8	0.08	0.10	0.8	44	136	1.3	43	60	0.7	107				263				
			0-.75	3.0	2.8	0.08	0.13	0.4	44	137	2.3	30	63	0.4	83				647				
119-2		2/18/72	.5-1.5	5.4	3.96	0.07	0.39	<0.01	110	166	5.9	63											
			3-3.6	4.1	2.74	0.07	0.04	<0.01	42	10	4.5	54											
			4.5-5.4	6.6	3.88	0.08	0.12	<0.01	47	129	5.1	61											
120-2			3.3.6	7.6	4.43	0.11	0.19	<0.03	106	282	6.6	73											
			6.6-7	1.3	0.17	0.09	0.08	<0.01	65	138	15.6	84											
			2.2-2.6	7.6	4.36	0.02	0.02	0.06	234	376	8.3	84											
121-2		10/73	WATER			.00004	.0246	.0007	.014		.001	.021						.00004		1.2			
122-2			ELUT.																				
			0-2.5	5.0		.00109	.0041	.0012	.088		.001	.033											
123-2			ELUT.																				
			0-2.5	4.5		-	-	-	-		-	-											
124-2			ELUT.																				
			0-2.5	7.2		.00075	.0166	.0008	.017		.001	.015											
125-2			ELUT.																				
			0-2.5	8.4		.00179	.0159	.0012	.014		.001	.019											
126-2			ELUT.																				
			0-2.5	8.5		.00094	.0126	.0006	.017		.001	.034											
127-2			ELUT.																				
			0-2.5	4.3		.00064	.0127	.0004	.017		.001	.020											
207-2		8/16/74	WATER			.00008												.00009		5.1		35	D
208-2		9/74	WATER			.00007												.00028		1.0		55	D
209-2		8/16/74	ELUT. 0-1.5			.00021												.00022		4.8		55	D
			Sed.				.12	0.5	36	160	0.6												
			ELUT. 1.5-3.5			.00043												.00043		3.9		54	D
			Sed.				.18	0.6	42	160	0.6												
		8/74	ELUT. 4.0-7.0			.00044												.00063		5.0		284	D
			Sed.				.0053	1.0	9	45	1.9	24											
			ELUT. 7.0-10.0			.00042												.00065		3.0		208	D
			Sed.				.0311	1.1	11	75	1.7	30											
			ELUT. 10.0-13.0			.00055												.00077		2.0		167	D
			Sed.				.0206	0.7	11	84	1.7	34											
210-2		8/16/74	ELUT. 0.0-3.0			.00049												.0005		4.8		89	D
			Sed.				.18	0.5	41	160	0.3												
		9/74	ELUT. 3.0-6.0			.0004												.00061		7.0		131	D
			Sed.				.0137	0.7	11	62	1.6	19											
			ELUT. 6.0-9.0			.00058												.0008		8.0		124	D
			Sed.				.0031	0.6	10	57	1.4	17											
			ELUT. 9.0-12.0			.00024												.00045		4.0		266	D
			Sed.				.0106	0.7	4	27	0.8	10											
211-2		8/16/74	ELUT. 0.0-1.5			.00043												.00045		6.9		95	D
			Sed.				.13	0.5	36	140	0.2												
			ELUT. 1.5-3.3			.0024												.00241		7.5		56	D
			Sed.				.27	0.7	42	180	0.6												
			ELUT. 3.3-4.6			.0018												.00181		6.9		45	D
			Sed.				.18	0.6	36	150	0.4												
			ELUT. 4.6-7.1			.0018												.00182		7.2		32	D
			Sed.				.2	0.6	28	150	0.6												
			ELUT. 7.1-8.6			.0016												.00162		6.9		25	D
			Sed.				.29	0.6	32	160	0.6												

D: Detected

REPORTED AS % OF DRY WEIGHT

Index No.	LOCATION	DATE	DEPTH	VS	COD	TKN	OIL & GREASE	Hg x10-4	Pb x10-4	Zn x10-4	Cd x10-4	Cu x10-4	Cr x10-4	As x10-4	Ni x10-4	SO_4 x10-4	PO_4 x10-4	N	S x10-4	BOD mg/1	CN x10-4	S.S. mg/1	PEST x10-7
212-2	OAKLAND OUTER HARBOR	8/16/74	ELUT. 0.0-2.5			.0012												.00121		4.8		228	D
			Sed.				.17	0.5	36	110	0.3												
			ELUT. 2.5-5.0			.0018												.00181		12.0		478	D
			Sed.				.071	0.5	14	87	0.1												
			ELUT. 5.0-7.5			.002												.00201		3.3		2000	D
			Sed.				.043	0.5	12	78	0.4												
213-2			ELUT. 0.0-2.5			.00021												.00023		3.6		277	D
			Sed.				.032	0.4	14	51	0.4												
		9/74	ELUT. 2.5-5.5			.00015												.00036		3.0		88	D
			Sed.				.0127	0.3	5	25	0.9	10											
			ELUT. 5.5-8.5			.00008												.00029		2.0		76	D
			Sed.				.0067	0.3	5	26	0.5	10											
214-2		8/16/74	ELUT. 0.0-2.3			.00092												.00093		3.6		280	D
			Sed.				.3	0.6	41	120	0.8												
		9/74	ELUT. 2.5-5.4			.00028												.00049		3.0		145	D
			Sed.				.0042	0.3	7	24	0.4	8											
			ELUT. 5.4-8.5			.00033												.00055		2.0		124	D
			Sed.				.0060	0.5	5	21	0.4	7											
			ELUT. 8.5-11.2			.00045												.00068		3.0		160	D
			Sed.				.002	0.5	10	41	0.9	22											
215-2		8/16/74	ELUT. 0.0-2.3			.00092												.00093		4.8		1900	D
			Sed.				.12	0.5	38	130	0.6												
			ELUT. 2.5-4.5			.0013												.0013		5.4		349	D
			Sed.				.58	0.6	40	140	0.6												
		9/74	ELUT. 5.0-8.0			.00041												.00062		2.0		266	D
			Sed.				.002	0.6	6	23	0.8	10											
			ELUT. 8.0-11.0			.00041												.00065		1.0		152	D
			Sed.				.0129	0.6	8	22	0.4	10											
			ELUT. 11.0-14.0			.00036												.00058		1.0		187	D
			Sed.				.0036	1.3	6	20	0.5	9											
216-2		8/16/74	ELUT. 0.0-2.3			.0007												.0007		7.2		2500	D
			Sed.				.84	0.5	41	160	0.6												
			ELUT. 2.5-5.0			.0013												.0013		7.5		21000	D
			Sed.				.61	0.7	43	160	0.5												
			ELUT. 5.0-7.5			.0016												.00161		6.9		470	D
			Sed.				.13	0.5	33	98	0.3												
			ELUT. 7.5-10.0			.0015												.00152		6.3		395	D
			Sed.				.17	0.5	32	90	0.3												
			ELUT. 10.0-12.1			.0012												.00121		5.7		602	D
			Sed.				.041	0.4	14	38	0.1												
217-2			ELUT. 0.0-2.5			.00098												.00099		7.5		633	D
			Sed.				.26	0.6	44	150	0.2												
			ELUT. 2.5-5.0			.00096												.00097		7.5		715	D
			Sed.				.18	0.7	49	150	0.2												
			ELUT. 5.0-7.5			.0014												.00141		9.0		1100	D
			Sed.				.3	0.6	44	170	0.6												
			ELUT. 7.5-10.0			.0015												.00151		6.0		200	D
			Sed.				.22	0.8	42	170	0.4												
			ELUT. 10.0-12.1			.0021												.00211		9.0		690	D
			Sed.				.23	0.8	46	190	0.3												
218-2			ELUT. 0.0-1.5			.00065												.00066		6.6		528	D
			Sed.				.22	0.6	38	160	0.6												
		9/74	ELUT. 1.5-5.5			.00035												.00058		4.0		88	D
			Sed.				.0002	1.1	5	23	0.8	8											
			ELUT. 5.5-7.5			.00024												.00046		3.0		233	D
			Sed.				.0012	0.9	6	24	0.9	8											
			ELUT. 7.5-10.5			.00022												.00046		4.0		59	D
			Sed.				.0002	0.3	7	19	0.5	7											

D:Detected

Index No.	LOCATION	DATE	DEPTH	VS	COD	TKN	OIL & GREASE	Hg x10-4	Pb x10-4	Zn x10-4	Cd x10-4	Cu x10-4	Cr x10-4	As x10-4	Ni x10-4	SO_4 x10-4	PO_4 x10-4	N	S x10-4	BOD mg/l	CN x10-4	S.S. mg/l	PEST x10-7
								REPORTED AS % DRY WEIGHT															
128-2	OAKLAND INNER HARBOR	3/11/71	0-.5	7.3	3.4			2.0	110	310													
			.5-1	4.8	8.6			0.08	19	81													
			1-1.5	4.4	3.2			0.06	15	110													
129-2			0-.5	6.8	9.6			1.0	100	280													
			.5-1	1.3	3.4			0.2	12	36													
130-2			0-.5	1.1	1.1			0.1	23	33													
131-2			0-.5	6.7	7.4			0.7	61	260													
			.5-1	0.7	0.1			0.02	33	23													
132-2			0-.5	2.1	0.8			0.2	32	68													
			.5-1	1.8	2.0			0.5	51	150													
			1-1.5	3.1	0.1			0.07	16	64													
133-2			0-.5	6.9	6.0			0.7	110	240													
			.5-1	4.4	3.7			2.0	71	150													
134-2			0-.5	4.6	3.1			0.5	85	170													
135-2			0-.5	7.5	5.3			0.7	96	230													
			.5-1	7.1	6.4			0.4	68	200													
			1-1.5	4.9	4.6			0.008	46	84													
136-2		9/73	0-2.5	2.1	1.0	0.02	0.06	0.3	31	65													
			2.5-5	2.3	0.9	0.05	0.03	0.1	14	41													
137-2			0-2.5	7.9	6.1	0.13	0.07	0.2	136	274													
			2.5-5	4.1	4.9	0.11	0.11	2.2	109	228													
138-2	ALCATRAZ	10/73	WATER			.00004	.0166	.0006	.014		.001	.024				2518				2.1		47	
139-2	OAKLAND INNER HARBOR		ELUT. 0-2.5	7.8		.00123	.0228	.0007	.016		.001	.026				2202							
140-2			ELUT. 0-2.5	8.0		.0011	.0245	.0004	.036		.002	.048				2247							
141-2			ELUT. 0-2.5	6.3		.00089	.0217	.0004	.019		.001	.016				2255							
142-2			ELUT. 0-2.5	8.2		.00125	.0192	.0004	.014		.001	.024				2202							
143-2			ELUT. 0-2.5	6.1		.00154	.0176	.0005	.016		.002	.024				2127							
144-2		10/73	ELUT. 0-2.5	6.1		.00103	.0293	.0025	.014		.002	.028				2292							
145-2		2/9/74	ELUT.			.00042												.00044		5		45.9	D
			Sed.				.0534	1.36	38.2	109.5	1.09												
146-2			ELUT.			.00073												.00075		5		99.0	D
			Sed.				.0646	1.67	35.3	78.0	1.46												
147-2			ELUT.			.00075												.00076		5		52.0	D
			Sed.				.0480	1.61	72.3	145	1.88												
148-2			ELUT.			.00043												.00044		5		122.4	D
			Sed.				.0882	2.9	82.7	189.5	2.04												
149-2		2/22/74	ELUT. 0-2.5			.00051												.00052		5		47.7	D
			Sed.				.16364	4.9	143.6	293	3.24												
			ELUT. 2.5-5			.00034												.00035		5		197.7	D
			Sed.				.01276	0.9	21.8	86	.84												
150-2			ELUT. 0-2.5			.00023												.00024		5		50.6	D
			Sed.				.07851	3.08	95.3	201	1.5												
			ELUT. 2.5-5			.00127												.00128		5		53.7	D
			Sed.				.01764	0.14	49.3	89	2.26												
151-2			ELUT. 0-2.5			.00127												.00128		5		95.4	D
			Sed.				.12005	3.22	56.3	133	1.7												
			ELUT. 2.5-5			.00018												.00021		5		102.6	D
			Sed.				.00925	0.12	14.2	23	1.22												
152-2			ELUT. 0-2.5			.00076												.00077		5		50.5	D
			Sed.				.06855	2.42	64.4	146	1.37												
			ELUT. 2.5-5			.00008												.00009		5		41.2	D
			Sed.				.03831	0.29	11.9	73	0.8												

D:Detected

REPORTED AS % OF DRY WEIGHT

Index No.	LOCATION	DATE	DEPTH	VS	COD	TKN	OIL & GREASE	Hg x10-4	Pb x10-4	Zn x10-4	Cd x10-4	Cu x10-4	Cr x10-4	As x10-4	Ni x10-4	SO_4 x10-4	PO_4 x10-4	N	S x10-4	BOD mg/l	CN x10-4	S.S. mg/l	PEST x10-7
1-3	SAN PABLO	8/31/72	0-.5	2.4	0.39	.0369	.0248	0.129	17	66													
	BAY		.25-1.25	3.1	3.1	.1010	.0531	0.365	40	104													
2-3	PT. DAVIS		0-.5	1.6	0.68	.0378	.0210	0.061	24	65													
			1-2.75	5.5	3.6	.1375	.0059	0.617	40	115													
3-3			0-.5	2.5	0.43	.0579	.0307	0.145	23	67													
			.5-2	4.7	2.8	.1081	.0361	0.383	46	98													
			2-3.5	4.4	3.2	.0852	.0444	0.275	46	100													
4-3	MARE ISLAND	5/17/71	SURF	8.35	4.53	0.170		0.23	58	177	1.2	61	120	<.01									
5-3	STRAIT	8/28/72	0-.75	8.3	4.9	0.16	0.15	0.7	36	232	1.1	75	379	2.9	206		—			—	—	—	D
			.75-1	8.6	4.7	0.17	0.12	0.6	37	181	1.0	63	376	6.9	243								D
6-3			0-.75	7.10	5.05	.0237	.0538	0.06	55	267	8.3	99	84	<.49	72								D
			.75-1	9.39	5.41	.0217	.0537	0.165	127	290	4.2	97	93	<.42	93								D
7-3			0-.75	6.18	6.87	.0063	.0426	0.091	49	310	4.7	117	89	<.5	130								D
			.75-1	7.85	5.71	.0402	.0449	0.129	55	164	4.1	111	90	<.47	135								D
8-3			0-.75	8.6	4.9	0.17	.07	0.5	27	163	1.2	53	337	5.3	207								D
			.75-1	8.4	5.1	0.19	.08	0.6	35	178	1.1	64	356	5.3	232								D
9-3			0-.75	7.93	5.48	.0843	.0205	0.091	62	267	6.7	116	85	<.51	80								D
			.75-1	7.29	5.59	.0263	.0433	0.053	44	227	6.6	102	84	<.46	89								D
10-3			0-.75	7.6	5.11	.0265	.0880	0.076	83	241	4.6	106	87	<.5	78								D
			.75-1	8.36	5.14	.0234	.1180	0.082	56	315	5.6	111	59	<.58	89								D
11-3			0-.75	8.2	5.1	0.17	.07	0.6	32	170	0.9	71	387	5.4	256								D
			.75-1	8.3	4.8	0.17	.07	0.5	35	169	1.1	68	389	3.7	245								D
12-3			0-.75	7.51	5.66	.0261	.0915	0.333	65	206	4.8	102	87	<.49	82								D
			.75-1	7.36	5.59	.0224	.0978	0.408	94	277	4.3	102	85	<.48	81								D
13-3			0-.75	7.73	3.54	.0169	.0797	0.258	33	154	3.2	71	62	<.35	55								D
			.75-1	8.63	5.51	.0258	.0658	0.232	50	188	5.0	110	90	<.52	90								D
14-3			0-.75	8.7	5.0	.19	.07	0.6	30	168	0.8	66	370	6.6	249								D
			.75-1	8.3	4.4	.16	.12	0.7	28	152	0.6	64	369	19.8	225								D
15-3			0-.75	7.72	5.29	.0343	.0451	0.339	66	187	4.7	117	84	<.44	131								D
			.75-1	7.27	5.13	.0214	.0797	0.098	53	180	4.4	110	83	<.46	75								D
16-3			0-.75	7.96	5.57	.0204	.0415	0.218	35	215	4.4	102	84	<.47	124								D
			.75-1	7.58	5.62	.0461	.0899	0.218	76	223	4.2	106	85	<.47	140								D
17-3			0-.75	8.0	4.9	.17	.09	0.6	26	162	1.0	57	370	5.6	239								D
			.75-1	9.8	4.8	.18	.09	0.6	33	157	1.0	63	347	5.2	228								D
18-3			0-.75	7.88	5.55	.0186	.0942	0.295	124	203	4.8	110	86	.5	81								D
			.75-1	7.9	5.04	.0164	.0792	0.193	105	195	4.8	109	90	.45	124								D
19-3			0-.75	7.77	5.02	.0191	.1290	0.021	79	285	4.4	79	79	.46	97								D
			.75-1	7.62	5.52	.0136	.0740	0.113	75	302	4.2	96	79	.45	104								D
20-3			0-.75	8.6	5.6	.17	.07	0.6	33	184	0.7	76	360	5.8	204								D
			.75-1	7.9	5.2	.17	.07	0.7	26	151	0.9	67	361	5.4	206								D
21-3			0-.75	7.74	4.45	.0157	.0587	0.037	74	232	3.7	63	67	<.37	81								D
			.75-1	5.92	4.13	.0148	.9321	0.033	69	229	3.8	65	65	<.4	88								D
22-3			0-.75	8.34	5.7	.0220	.0419	0.062	83	271	4.6	74	83	<.47	102								D
			.75-1	8.8	7.0	.0156	.0321	0.032	86	299	4.8	76	72	<.47	86								
23-3		9/72	0-1.5					0.9	72	138	1.6	76	86	1.3	105								
24-3			0-1.5					1.0	52	148	1.5	86	93	3.3	115								
25-3			0-1.5					0.6	53	138	1.4	76	104	2.6	118								
26-3			0-1.5					0.7	53	126	1.3	82	106	2.8	106								
27-3			0-1.5					0.6	48	105	1.2	79	95	2.7	100								
28-3			0-1.5					0.6	48	128	1.2	73	98	2.7	101								
29-3			0-1.5					0.8	50	135	1.2	79	86	2.8	112								
30-3			0-1.5					0.5	50	134	1.3	76	101	2.9	113								
31-3		8/73	WATER			.00008	.0158	0.0007		.012	.001	.020				1375		.0001		7.2		58	
32-3			ELUT. 0-2.5	9.2		.00069	.0146	.0001		.065	.001	.033				1264		.0007				67	
			ELUT. 2.5-5	8.4		.00107	.0141	.0001		.021	.001	.020				844		.00109				117	
			ELUT. 5-7.5	8.9		.0017	.0134	.0001		.024	.001	.023				1202		.0017				160	
33-3			ELUT. 0-2.5	8.2		.00076	.0114	.0002		.027	.001	.018				1202		.00076				82	
			ELUT. 2.5-5	8.3		.00179	.0198	.0001		.021	.001	.013				1177		.0018				134	
			ELUT. 5-7.5	8.8		.00206	.0132	.0001		.021	.001	.022				1210		.00207				148	
34-3			ELUT. 0-2.5	9.0		.00091	.0148	.0002		.027	.001	.023				873		.00091				72	
			ELUT. 2.5-5	9.2		.00146	.0092	.0002		.015	.001	.020				1160		.00148				114	
34-3			ELUT. 5-7.5	8.8		.00146	.0118	.0001		.015	.001	.014				1173		.00147				147	
			ELUT. 7.5-10	8.9		.00185	.0153	.0002		.016	.003	.019				1181		.00186				183	
35-3			ELUT. 0-2.5																				
			ELUT. 2.5-5	8.1		.00337	.0151	.0003		.021	.001	.020				1161		.00338				148	
			ELUT. 5-7.5	10.3		.00074	.0121	.0002		.033	.001	.024				1091		.00075				172	
36-3			ELUT. 0-2.5	9.1		.00223	.0106	.0001		.021	.001	.029				1214		.00225				121	
			ELUT. 2.5-5	9.0		.00114	.0119	.0001		.013	.003	.016				1177		.00116				119	
			ELUT. 5-7.5	9.2		.00174	.0111	.0001		.019	.004	.030				1247		.00176				198	
140-3			ELUT. 0-2.5	8.3		.00084	.0118	.0003		.001	.004	.013				1210		.00086				51	
			ELUT. 2.5-5	8.8		.00189	.0116	.0003		.001	.004	.023				1223		.00191				99	

D:Detected

REPORTED AS % OF DRY WEIGHT

Index No.	LOCATION	DATE	DEPTH	VS	COD	TKN	OIL & GREASE	Hg x10-4	Pb x10-4	Zn x10-4	Cd x10-4	Cu x10-4	Cr x10-4	As x10-4	Ni x10-4	SO_4 x10-4	PO_4 x10-4	N	S x10-4	BOD mg/1	CN x10-4	S.S mg/1	PEST. x10-7
(Cont'd)																							
140-3	MARE ISLAND STRAIT	8/73	ELUT. 5-7.5	9.2		.00226	.0103	.0001	.011		.004	.014				1214		.00228				75	
			ELUT. 7.5-10	9.0		.00318	.0154	.0006	.013		.005	.022				1198		.0032				79	
37-3	SURFACE	2/6/73	WATER		.0012	.00003		.0002	.08	.38		.08	.22		.14								
	SURFACE FILTERED		WATER		.0006	.00004		.0002	.08	.12		.08	.11		.09								
38-3	BOTTOM		WATER		.0135	.00012		.0002	.15	.42		.24	.17		.14								
	BOTTOM FILTERED		WATER		.0077	.00009		.0001	.15	.16		.06	.11		.09								
39-3	SURFACE	2/13/73	WATER		.0070	.00007		.0003	.08	.29		.12	.17		.20								
	SURFACE FILTERED		WATER		.0070	.00007		.0003	.08	.16		.06	.11		.09								
40-3	BOTTOM		WATER		.0031	.00011		.0003	.08	.29		.08	.11		.20								
	BOTTOM FILTERED		WATER		.0013	.00006		.0002	.08	.21		.06	.11		.20								
41-3	SURFACE		WATER		.0077	.00007		.0001	.08	.29		.08	.11		.04								
	SURFACE FILTERED		WATER		.0031	.00005		.0001	.08	.21		.06	.11		.04								
42-3	BOTTOM		WATER		.0033	.00006		.0002	.08	.25		.06	.11		.09								
	BOTTOM FILTERED		WATER		.0025	.00005		.0002	.08	.21		.06	.11		.09								
43-3	SURFACE		WATER		.0033	.00008		.0001	.08	1.04		.13	.22		.09								
	SURFACE FILTERED		WATER		.0023	.00007		.0001	.08	.35		.12	.04		.05								
44-3	BOTTOM		WATER		.0054	.00013		.0002	.12	1.11		.15	.17		.15								
	BOTTOM FILTERED		WATER		.0029	.00004		.0002	.12	.59		.15	.04		.15								
45-3	SURFACE		WATER		.0058	.00006		.0001	.12	.99		.12	.09		.15								
	SURFACE FILTERED		WATER		.0034	.00003		.0001	.12	.39		.10	.04		.15								
46-3	BOTTOM		WATER		.0031	.00005		.0002	.15	1.29		.17	.09		.20								
	BOTTOM FILTERED		WATER		.0016	.00004		.0001	.12	.23		.08	.04		.20								
47-3	SURFACE		WATER		.0016	.00007		.0002	.08	1.03		.21	.09		.25								
	SURFACE FILTERED		WATER		.0014	.00005		.0002	.08	.29		.10	.04		.15								
48-3	BOTTOM		WATER		.0025	.00014		.0002	.12	.48		.13	.17		.20								
	BOTTOM FILTERED		WATER		.0020	.00003		.0001	.12	.36		.12	.09		.20								
49-3	SURFACE	1/9/73	WATER		.0180	.00012		.0003	.13	.28		.21	.15		.12								
	SURFACE FILTERED		WATER		-	-		.0001	.13	.28		.12	.08		.09								
50-3	BOTTOM		WATER		.0333	.00012		.0001	.14	.02		.11	.11		.07								
	BOTTOM FILTERED		WATER		-	-		.0001	.14	.33		.10	.06		.04								
51-3	SURFACE		WATER		.0223	.00011		.0001	.16	.92		.20	.11		.08								
	SURFACE FILTERED		WATER		-	-		.0001	.08	.37		.12	.04		.04								
52-3	BOTTOM		WATER		.0193	.00014		.0002	.17	.89		.16	.11		.06								
	BOTTOM FILTERED		WATER		-	-		.0001	.15	.42		.10	.04		.04								
53-3	SURFACE		WATER		.0188	.00011		.0001	.13	.75		.12	.11		.07								
	SURFACE FILTERED		WATER		-	-		.0001	.08	.33		.08	.04		.04								
54-3	BOTTOM		WATER		.0163	.00005		.0005	.10	.84		.05	.04		.04								
	BOTTOM FILTERED		WATER		-	-		.0002	.08	.42		.05	.04		.04								
55-3	SURFACE		WATER		.0276	.00006		.0001	.09	.77		.05	.07		.04								
	SURFACE FILTERED		WATER		-	-		.0001	.08	.33		.05	.07		.04								
56-3	BOTTOM		WATER		.0249	.00008		.0002	.09	.60		.11	.07		.07								
	BOTTOM FILTERED		WATER		-	-		.0001	.08	.33		.11	.07		.04								
57-3	SURFACE		WATER		.0218	.00007		.0002	.15	.82		.10	.11		.04								
57-3	SURFACE FILTERED	1/9/73	WATER		-	-		.0001	.15	.14		.05	.08		.04								
58-3	BOTTOM	1/23/73	WATER		.0016	.0001		.0002	.08	.23		.12	.04		.04								
	BOTTOM FILTERED		WATER		.0004	.00009		.0001	.08	.14		.12	.04		.04								
59-3	SURFACE		WATER		.0012	.00011		.0002	.08	.28		.10	.04		.04								
	SURFACE FILTERED		WATER		.0006	.00008		.0001	.08	.14		.08	.04		.04								
60-3	BOTTOM		WATER		.0015	.00006		.0003	.08	.14		.10	.04		.04								
	BOTTOM FILTERED		WATER		.0008	.00005		.0002	.08	.14		.08	.04		.04								
61-3	BOTTOM		WATER		.0012	.00006		.0002	.08	.09		.10	.04		.04								
	BOTTOM FILTERED		WATER		.0012	.00003		.0001	.08	.04		.05	.04		.04								
62-3	SURFACE		WATER		.0012	.00006		.0002	.08	.14		.12	.04		.04								
	SURFACE FILTERED		WATER		.0008	.00005		.0001	.08	.14		.12	.04		.04								
63-3	BOTTOM		WATER		.0015	.00006		.0002	.08	.14		.15	.04		.04								
	BOTTOM FILTERED		WATER		.0015	.00004		.0001	.08	.14		.20	.04		.04								
64-3	SURFACE		WATER		.0039	.00004		.0003	.08	.70		.08	.17		.09								
	SURFACE FILTERED		WATER		.0039	.00004		.0001	.08	.16		.08	.11		.09								
65-3	BOTTOM	2/6/74	WATER		.0014	.00005		.0002	.15	.75		.06	.11		.14								
	BOTTOM FILTERED		WATER		.0004	.00004		.0001	.08	.16		.08	.11		.09								
66-3	SURFACE		WATER		.0141	.00003		.0002	.08	.61		.06	.22		.09								
	SURFACE FILTERED		WATER		.0093	.00003		.0001	.08	.21		.08	.11		.09								
67-3	BOTTOM		WATER		.0019	.00012		.0001	.22	.51		.10	.11		.20								
	BOTTOM FILTERED		WATER		.0008	.00004		.0001	.08	.16		.08	.11		.09								
146-3	MARE ISLAND STRAIT	6/31/74	ELUT. 0-2.5			.00024												.00026		9.0		78	
			Sed.				.0840	1.1	62	143	2.4												
			ELUT. 2.5-5.0			.00026												.00029		8.1		84	
			Sed.				.0820	0.8	63	172	2.0												
			ELUT. 5.0-7.5			.00024												.00026		8.4		72	
			Sed.				.0640	1.4	79	189	2.7												
			ELUT. 7.5-10.0			.00034												.00037		7.8		81	
			Sed.				.0260	1.0	59	159	2.3												
			ELUT. 10.0-12.5			.00054												.00056		8.4		87	
			Sed.				.02	0.1	65	170	2.6												
147-3			ELUT. 0-2.3			.00022												.00023		11.6		73	
			Sed.				.0160	0.1	59	165	2.3												
			ELUT. 2.5-5.0			.00008												.00010		9.0		76	
			Sed.				.01	1.1	62	149	.26												
			ELUT. 5.0-6.7			.00012												.00014		8.4		99	
			Sed.				.014	1.4	62	166	2.7												
			ELUT. 6.7-9.2			.00010												.00012		6.8		94	
			Sed.				.0080	1.1	56	143	3.5												
148-3			ELUT. 0-2.5			.00018												.00019		9.6		104	
			Sed.				.0240	0.1	52	167	2.6												
			ELUT. 2.5-5.0			.00022												.00023		8.4		66	
			Sed.				.0380	1.0	50	155	2.7												
			ELUT. 5-7.5			.00018												.00020		9.0		87	
			Sed.				.0240	1.6	70	171	2.7												
			ELUT. 7.5-10			.00030												.00032		7.8		62	
			Sed.				.0400	1.0	61	160	3.0												
			ELUT. 10-12.5			.00024												.00026		7.4		65	
			Sed.				.0220	1.5	65	151	2.7												
			ELUT. 12.5-14			.00024												.00026		6.0		81	
			Sed.				.0240	1.5	60	165	3.0								5			
149-3			WATER			.000036												.000068		5		65	

REPORTED AS % OF DRY WEIGHT

Index No	LOCATION	DATE	DEPTH	VS	COD	TKN	OIL & GREASE	Hg x10-4	Pb x10-4	Zn x10-4	Cd x10-4	Cu x10-4	Cr x10-4	As x10-4	Ni x10-4	SO4 x10-4	PO4 x10-4	N	S x10-4	BOD mg/1	CN x10-4	S.S. mg/1	PEST x10-7
150-3	MARE ISLAND STRAIT	6/31/74	ELUT. 0-1.8			.00024												.00027		9.4		93	
			Sed.				.032	1.3	64	165	2.8												
			ELUT.			.00018												.00022		7.2		65	
			Sed.				.024	0.1	57	151	2.8												
			ELUT. 3.9-6.4			.00008												.00010		7.2		82	
			Sed.				.0160	1.6	62	174	3.2												
			ELUT. 6.4-8.6			.00010												.00011		6.8		143	
			Sed.				.006	1.5	61	158	3.1												
151-3		6/7/74	ELUT. 0-2.5			.0011												.0011		4.0		110	D
			Sed.				.02	0.56	74.4	222	<1.77												
			ELUT. 2.5-5.0			.0015												.00151		5		250	D
			Sed.				.09	0.22	44.9	150	<1.47												
			ELUT. 5.0-7.5			.0018												.00181		9		136	D
			Sed.				.07	1.08	87.1	225.7	<1.83												
			ELUT. 7.5-10			.0029												.0029		4		154	D
			Sed.				.15	0.53	46.7	155.7	<1.97												
152-2			ELUT. 0-2.5			.0014												.0014		6		226	D
			Sed.				.08	0.45	51.7	155.2	<1.09												
			ELUT. 2.5-5			.0023												.0023		7		176	D
			Sed.				.11	1.28	90.0	300	<2.00												
			ELUT. 5-7.5			.0026												.0026		3		55	D
			Sed.				.13	0.35	86.0	213	<2.11												
			ELUT. 7.5-10			.0024												.0024		8		106	D
			Sed.				.14	0.75	83.3	235	<1.66												
153-3			ELUT. 0-2.5			.0014												.0014		7		186	D
			Sed.				.10	0.44	40.0	131.6	2.44												
			ELUT. 2.5-5			.0027												.0027		7		160	D
			Sed.				.13	0.63	70.2	140.9	<2.76												
			ELUT. 5-7.5			.0021												.0021		7		142	D
			Sed.				.07	0.61	54.3	156.3	<1.52												
154-3			ELUT. 7.5-10			.0022												.00221		9		154	D
			Sed.				.05	0.36	24.6	84.4	<1.8												
			ELUT. 10-12.5			.0032												.00321		6		126	D
			Sed.				.07	0.72	44.7	227.4	<2.34												
154-3			ELUT. 0-2.5			.0007												.00072		7		208	D
			Sed.				.06	0.35	59.5	119.2	<2.43												
			ELUT. 2.5-4			.0009												.00091		8		170	D
			Sed.				.13	0.37	61.0	214.9	<2.19												
155-3			ELUT. 0-2.5			.0010												.0011		13		142	D
			Sed.				.12	0.26	44.2	623.7	<1.86												
156-3			ELUT. 0-2.5			.0018												.0018		7		268	D
			Sed.				.31	0.42	37.9	203.3	<1.86												
			ELUT. 2.5-3.8			.0020												.0020		7		102	D
			Sed.				.30	0.36	61.7	153.0	<2.97												
157-3			ELUT. 0-2.5			.0012												.0012		6		88	D
			Sed.				.15	0.28	41.3	161.1	1.52												
			ELUT. 2.5-5			.0018												.0018		5		126	D
			Sed.				.14	0.35	62.2	206.3	<1.63												
158-3			ELUT. 0-2.5			.0013												.00131		8		108	D
			Sed.				.17	0.52	54.2	186.7	<1.87												
			ELUT. 2.5-5.0			.0010												.0010		6		114	D
			Sed.				.10	0.45	58.3	145.6	<1.45												
			ELUT. 5.0-7.5			.0015												.00155		5		140	D
			Sed.				.02	1.33	98.8	221.0	<2.08												
			ELUT. 7.5-10			.0024												.00241		5		82	D
			Sed.				.02	0.82	71.4	285.5	<2.85												
68-3	PETALUMA	9/9/71	SURF.	5.8	5.5	0.12	0.09	0.20	31	59													
69-3	CREEK		SURF.	8.2	6.3	0.20	0.16	0.49	80	120													
70-3			SURF.	1.7	0.72	0.02	0.02	0.44	12	31													
71-3	BEACON #6	6/1/72	SURF.	7.7	3.9	0.14	0.07	0.8	35	143													
72-3	BEACON #14		SURF.	8.2	3.9	0.14	0.06	0.7	33	188													
73-3	BEACON #18		SURF.	8.1	4.1	0.15	0.08	0.7	34	170													
74-3		11/30/73	ELUT. 0-.5			.0008												.00081		6.6		17	D
			Sed.				0.12	0.7	52	147	2.0												
75-3			ELUT. 0-.5			.0017												.0017		8.4		57925	D
			Sed.				0.09	0.9	38	121	1.9												
76-3			ELUT. 0-.5			.0008												.0008		10.1		109120	D
			Sed.				0.07	0.2	46	126	1.9												
77-3			ELUT. 0-.5			.0013												.0013		9.5		79740	D
			Sed.				0.10	0.5	47	128	1.5												
78-3			ELUT. 0-.5			..0017												.0017		5.0		87700	D
			Sed.				0.08	0.4	51	149	1.6												
79-3			ELUT. 0-.5			.0017												.0017		6.8		22	D
			Sed.				0.07	0.9	45	120	1.4												
80-3			Sed. 0-.5				0.09	0.9	57	101	1.6												
81-3			Sed. 0-.5				0.12	0.4	43	114	1.5												
82-3			Sed. 0-.5				0.10	0.6	46	128	1.8												

D: Detected

REPORTED AS % DRY WEIGHT

Index No.	LOCATION	DATE	DEPTH	VS	COD	TKN	OIL & GREASE	Hg x10-4	Pb x10-4	Zn x10-4	Cd x10-4	Cu x10-4	Cr x10-4	As x10-4	Ni x10-4	SO4 x10-4	PO4 x10-4	N	S x10-4	BOD mg/l	CN- x10-4	S.S. mg/l	PEST x10-7
83-3	PETALUMA		Sed. 0-.5				0.12	0.6	41	109	1.5												
84-3			Sed. 0-.5				0.18	0.2	44	81	1.7												
85-3			Sed. 0-.5				0.13	0.8	46	119	2.0												
86-3			Sed. 0-.5				0.05	0.5	26	48	1.7												
87-3			Sed. 0-.5				0.03	0.3	18	34	1.2												
88-3			Sed. 0-.5				0.12	0.8	40	116	2.0												
89-3	PINOLE SHOAL	11/8/71	0-1.5	3.14	2.26	0.04	0.02	0.1	27.98	54.55													
90-3			0-2.5	1.82	0.72	0.02	0.01	0.05	25.27	47.51													
91-3		11/9/71	0-2.5	4.58	2.62	0.08	0.03	0.3	37.52	92.92													
92-3			0-2.5	6.55	2.20	0.07	0.01	0.35	10.48	64.61													
93-3		11/8/71	0-2.5	6.05	3.45	0.12	0.03	0.32	25.16	99.73													
94-3			0-2.5	4.04	3.26	0.09	0.02	0.12	14.60	63.27													
95-3		10/20/71	0-2.5	5.79	3.93	0.13	0.06	0.24	16.19	97.10													
96-3			0-2.5	6.28	4.74	0.15	0.04	0.04	20.52	75.52													
97-3			0-2.5	5.85	4.34	0.15	0.04	0.05	14.46	74.08													
98-3		10/22/71	0-2.5	4.55	2.78	0.09	0.04	0.29	13.39	74.38													
99-3		10/21/71	0-2.5	5.70	4.18	0.13	0.05	0.13	10.56	68.6													
100-3			0-2.5	5.62	3.99	0.14	0.05	0.14	13.79	72.41													
101-3		10/4/71	0-.6	5.9	4.4	0.11	0.04	0.5	11	89													
			3.2-3.8	5.7	4.2	0.13	0.02	0.2	11	92													
			6.9-7.5	6.3	4.1	0.12	0.04	0.1	7	72													
102-3			0-.6	3.6	2.5	0.06	0.03	0.2	13	65													
			7.5-8.1	4.3	3.6	0.07	0.05	0.3	14	78													
			14.4-16	5.4	4.4	0.1	0.03	0.3	13	99													
103-3		11/19/73	H_2O			.0057												.00571		12.8		48	D
104-3			ELUT. 0-2.5			.1075												.10751		4.8		98	D
			Sed.				.1074	0.3	26	47													
105-3			ELUT. 0-2.5			.1555												.15551		4.4		83	D
			Sed.				.0655	0.2	24	41													
106-3			ELUT. 0-2.5			.1499												.1499		2.4		95	D
			Sed.				.0621	0.3	28	45													
107-3			ELUT. 0-2.5			.1103												.1103		1.6		88	D
			Sed.				.0325	0.1	23	35													
108-3			ELUT. 0-2.5			.1273												.1273		0.8		89	D
			Sed.				.0369	0.1	21	36													
109-3		5/17/73	0-2.5	5.7	3.4	0.09	0.02	0.2	15	60													
			2.5-7.5	7.0	5.0	0.12	0.01	0.2	18	83													
			7.5-10	7.3	4.7	0.23	0.01	1.0	25	109													
110-3		5/29/73	0-2.5	6.7	5.0	0.17	0.05	0.1	24	81													
			2.5-7.5	6.2	4.2	0.16	0.04	0.2	20	77													
			7.5-10	6.2	4.2	0.15	0.05	0.1	17	85													
111-3		6/1/73	0-2.5	6.3	4.8	0.17	0.05	0.2	22	89													
			2.5-7.5	6.0	4.1	0.15	0.04	0.1	20	71													
112-3		6/4/73	0-2.5	7.5	4.0	0.15	0.07	0.5	42	173													
			2.5-7.5	6.6	3.5	0.12	0.07	4.0	32	106													
			7.5-12.5	6.4	4.2	0.15	0.04	0.2	19	90													
113-3			0-2.5	6.0	3.0	0.10	0.06	0.8	43	120													
			2.5-7.5	4.2	2.4	0.08	0.04	0.1	20	79													
			7.5-15	5.4	3.5	0.11	0.04	0.1	17	79													
114-3		6/8/73	0-2.5	6.7	3.4	0.11	0.08	0.4	38	123													
			2.5-7.5	4.9	2.9	0.09	0.11	0.1	14	77													
			7.5-10	2.7	1.2	0.04	0.06	0.1	13	59													
115-3		6/21/73	0-2.5	8.5	0.6	0.03	0.08	0.1	38	63													
			5-10	7.7	1.9	0.07	0.02	0.5	20	78													
116-3																							
		6/22/73	0-2.5	7.3	2.8	0.07	0.04	0.4	32	47													
			2.5-7.5	4.7	1.8	0.05	0.02	0.2	12	55													
117-3			0-2.5	3.1	2.2	0.04	0.02	0.1	14	66													
			2.5-7.5	3.2	2.2	0.05	0.03	0.1	12	63													
118-3		6/25/73	0-2.5	1.7	0.5	0.03	0.01	0.1	19	66													
			2.5-7.5	2.4	1.5	0.02	0.01	0.1	11	55													
119-3		6/27/73	0-2.5	3.4	1.6	0.04	0.03	0.2	27	90													
			2.5-7.5	2.0	0.9	0.03	0.04	0.2	26	83													
			7.5-10	2.5	1.2	0.02	0.02	0.1	13	57													
120		7/9/73	0-2.5	4.2	2.3	0.07	0.06	0.3	33	102													
			2.5-7.5	3.5	1.3	0.02	0.02	0.1	13	70													
			7.5-10	3.3	2.1	0.05	0.05	0.1	13	75													
121-3	NAPA	7/29/71		7.4	6.3	0.16	0.08	0.45	23	117													
122-3	RIVER	7/30/71		7.2	5.9	0.16	0.07	0.40	35	116													
123-3		7/29/71		11.6	17.0	0.30	0.14	0.11	18	89													
124-3		8/2/71		6.0	4.4	0.12	0.06	0.24	23	87													
125-3		8/5/71		2.9	1.5	0.04	0.02	0.10	14	56													
126-3		8/2/71		6.3	3.8	0.12	0.06	0.24	13	84													
127-3		8/3/71		4.5	2.0	0.07	0.02	0.15	19	85													
128-3				2.8	1.1	0.03	0.01	0.12	10	66													
129-3				5.3	3.6	0.11	0.09	0.46	27	93													
130-3		8/4/71		5.3	1.9	0.08	0.08	0.12	24	94													
131-3				6.7	5.4	0.20	0.19	0.45	42	139													
142-3		11/71	SUSP.																				
			Sediment	9.3	2.0	.2976	.0449	0.5	54	159													D
			0-.5	6.2	6.13	.1576	.0704	0.447	13	73													D
			3.8-4.3	5.9	4.14	.1242	.0762	0.543	11	81													D
			6.8-7.5	7.4	3.95	.1882	.039	0.629	12	70													D
143-3				4.7	1.86	.1186	.0326	0.237	7	42													D
144-3			SUSP.																				
			Sediment	2.4	0.34	.0805	.0459	0.176	20	54													D
				3.1	0.63	.0363	.0341	0.175	3	32													D
145-3			SUSP.																				D
			Sediment	7.9	3.39	.3041	.1021	0.454	77	175													D
			0.0-.5	5.7	3.85	.2080	.1233	0.452	13	70													D
			4.5-5.0	7.8	5.27	.2001	.0567	0.327	7	58													D
			8.7-10.0	6.9	4.21	.1969	.0312	0.496	9	58													D
132-3	SONOMA	8/10/71		4.8	4.7	0.21	0.25	0.18	10	37													
133-3	CREEK			2.3	0.45	0.01	0.02	0.11	10	61													
134-3		8/12/71		5.6	2.5	0.08	0.04	0.27	22	116													
135-3		8/11/71		7.7	4.4	0.17	0.10	0.81	48	172													
136-3		8/12/72		6.4	5.6	0.14	0.08	0.71	27	89													
141-3		11/71	SUSP.																				
			Sediment	8.6	3.9	.1685	.027	.440	81	145										1.9		200,000	D
			0.0-0.4	8.5	8.51	.2306	.0668	.408	26	103													D
			3.4-3.8	7.8	6.34	.4492	.0237	.0287	24	86													D
			7.1-7.5	16.6	21.36	.5242	.2744	.345	26	53													D

D: Detected

REPORTED AS % OF DRY WEIGHT

Index No.	LOCATION	DATE	DEPTH	VS	COD	TKN	OIL & GREASE	Hg x10-4	Pb x10-4	Zn x10-4	Cd x10-4	Cu x10-4	Cr x10-4	As x10-4	Ni x10-4	SO_4 x10-4	PO_4 x10-4	N	S x10-4	BOD mg/l	CN x10-4	S.S. mg/l	PEST. x10-7
1-4	CARQUINEZ STRAIT	6/12/73	0-2.5	4.4	2.1	0.08	0.02	0.1	16	73													
			2.5-7.5	4.3	2.1	0.07	0.01	0.1	16	47													
2-4			0-2.5	8.3	6.1	0.18	0.09	0.7	66	102													
3-4			0-2.5	8.4	6.3	0.18	0.07	0.7	51	91													
			2.5-7.5	9.2	7.4	0.22	0.09	0.5	56	96													
			7.5-12.5	8.5	6.3	0.22	0.08	0.8	48	174													
			12.5-17.5	6.1	5.7	0.19	0.09	0.6	58	167													
			17.5-20	6.6	4.9	0.16	0.09	0.4	50	135													
4-4		6/13/73	0-5	2.5	0.9	0.02	0.01	0.1	21	66													
5-4			5-7.5	2.2	0.4	0.02	0.01	0.1	14	64													
6-4			0-2.5	2.3	0.4	0.01	0.01	0.1	22	66													
			2.5-7.5	3.6	1.2	0.02	0.02	0.2	21	54													
7-4		6/18/73	0-2.5	4.2	3.3	0.04	0.04	0.1	13	54													
			2.5-5	5.8	3.9	0.02	0.02	0.1	11	54													
			5-7.5	4.9	2.8	0.01	0.01	0.1	13	50													
8-4		6/19/73	0-2.5	5.9	4.3	0.01	0.01	0.2	22	69													
			2.5-7.5	6.0	4.6	0.06	0.06	0.1	19	54													
			7.5-12.5	6.0	5.9	0.05	0.05	0.1	16	60													
			12.5-15	5.0	3.4	0.08	0.08	0.1	15	51													
9-4			0-2.5	5.3	7.7	0.06	0.06	0.1	17	46													
			2.5-7.5	9.3	13.3	0.08	0.08	0.3	18	57													
			7.5-12.5	8.5	11.8	0.10	0.10	0.1	21	47													
10-4	SUISUN BAY	7/24/71	SURF.	7.7	6.4	0.17	0.04	0.05															D
11-4			SURF.	7.9	6.1	0.19	0.05	0.04															D
12-4			SURF.	7.7	5.7	0.16	0.16	0.05															D
13-4		11/23/71	0-2.5																				
14-4		11/19/71	0-2.5																				
15-4		11/23/71	0-2.5																				
16-4		11/22/71	0-2.5																				
17-4			0-2.5																				
18-4		11/23/71	0-2.5																				
19-4		7/72		1.1	0.3	0.01	0.01	0.1	120	66													
20-4				1.4	0.57	0.01	0.01	0.01	9.4	46													
21-4				2.2	1.1	0.04	0.02	0.2	13.0	47													
22-4				6.9	5.5	0.18	0.03	0.1	22.0	85													
23-4				3.5	3.8	0.07	0.03	0.04	16.0	69													
24-4				2.1	0.6	0.02	0.01	0.1	15.0	45													
25-4		7/74	WATER			.00004												.00005		1.4			D
			WATER			.00005												.00006		0.4			D
26-4			ELUT.																				
			0.0-1.7			.00005												.00006		7.0			D
			ELUT.			.00008												.00009		6.6			D
27-4			ELUT.																				
			0.0-2.3			.00015												.00016		3.4			D
			ELUT.			.00007												.00008		3.6			D
			ELUT.																				
			2.5-3.8			.00009												.0001		2.4			D
						.00018												.00019		3.0			D
28-4			ELUT.																				
			0.0-15			.00007												.00008		4.4			D
						.00002												.00003		4.4			D
			ELUT.																				
			1.5-3.5			.00029												.00003		3.6			D
						.00024												.00025		4.4			D
29-4			ELUT.																				
			0.0-2.1			.00011												.00012		3.6			D
						.00009												.0001		4.4			D
			ELUT.																				
			2.5-4.7			.0003												.00031		4.0			D
						.00022												.00023		4.4			D
			5.0-7.1			.00028												.00029		4.4			D
						.00021												.00022		3.8			D
			7.5-8.6			.00012												.00013		2.2			D
						.00019												.0002		2.2			D
30-4			ELUT.																				
			0.0-2.5			.00019												.0002		3.8			D
						.00005												.00006		3.8			D
31-4			0.0-2.3			.00009												.0001		6.6			D
			0.0-2.3			.00017												.00018		3.4			D
			2.5-4.8			.00046												.00047		3.4			D
						.00033												.00033		1.8			D
			5.0-6.5			.00025												.00026		2.0			D
						.00020												.0002		0.6			D
32-4			ELUT.																				
			0.0-2.2			.00004												.00005		2.4			D
						.00005												.00005		3.0			D
			2.5-4.7			.00054												.00055		1.6			D
						.00034												.00035		1.2			D
33-4			ELUT.																				
			0.0-2.5			.00002												.00003		1.2			D
						.00006												.00006		1.4			D
			2.5-5.0			.00025												.00026		1.8			D
						.00021												.00022		2.4			D
34-4			ELUT.																				
			0.0-2.4			.00011												.00012		1.2			D
						.00021												.00022		1.6			D
35-4			ELUT.																				
			0.0-2.4			.00014												.00015		1.6			D
						.00014												.00015		1.8			D
36-4			ELUT.																				
			0.0-2.0			.00007												.00008		1.6			D
			0.0-2.0			.00006												.00006		1.6			D

D: Detected

TABLE 1-2 PESTICIDES (PPB)

		PCB		CHLORINATED HYDROCARBON PEST.													
Index No.	DEPTH	AROCLOR 1254	OTHER	LINDANE	BHC	DIELDRIN	TOXAPHENE	P_1P-DDE	O_1P-DDE	P_1P-DDD	P_1P-DDT	O_1P-DDT	HEPTACHLOR	HEPTACHLOR LIKE	ALDRIN	ENDRIN	CHLORDANE
6-1	0.0-1	19.4						1.29	1.07	0.71	1.78						
7-1	0.0-1	14.2						1.07	1.60	0.64							
8-1	1.0-2.5	27.5							1.34	1.34	3.12						
10-1	H_2O	35.5							3.52	1.28	6.20						
	0.0-2.5												0.41	0.62			
	2.5-5.0												0.24	0.79			
11-1	-																
14-1	.75-1.5		0.23	0.01	<0.01	<0.01	<0.01	<0.01		0.04	<0.01		<0.01		<0.01	<0.01	<0.01
	0-0.75		0.09	0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01		<0.01		<0.01	<0.01	<0.01
15-1	.75-1.5		0.01	0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01		<0.01		<0.01	<0.01	<0.01
	0-.75		0.11	0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01		<0.01		<0.01	<0.01	<0.01
16-1	.75-1.5		0.04	0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01		<0.01		<0.01	<0.01	<0.01
	0-.75		0.12	0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01		<0.01		<0.01	<0.01	<0.01
17-1	.75-1.5		0.10	0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01		<0.01		<0.01	<0.01	<0.01
	0-.75		0.09	0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01		<0.01		<0.01	<0.01	<0.01
18-1	.75-1.5		<0.01	0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01		<0.01		<0.01	<0.01	<0.01
	0-.75		0.08	0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01		<0.01		<0.01	<0.01	<0.01
19-1	.75-1.5		<0.01	0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01		<0.01		<0.01	<0.01	<0.01
	0-.75		0.02	0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01		<0.01		<0.01	<0.01	<0.01
20-1	.75-1.5		<0.01	0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01		<0.01		<0.01	<0.01	<0.01
	0-.75		0.01	0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.01		<0.01		<0.01	<0.01	<0.01
25-1	H_2O	17.3						0.33	0.53	0.33		0.53					
	0-2.5				<0.27 chc												
	2.5-5.0				<0.27 chc												
	5-7.5				<0.27 chc												
26-1	0-2.5				<0.16 chc												
27-1	0-1.2				<0.13 chc												
28-1	12.5-15				<0.27 chc												
29-1	10.-12.5				<0.27 chc												
30-1	H_2O	59.1									7.8						
	0-2.5				<0.27 chc												
	2.5-5				<0.27												
	5-7.5				<0.27												
31-1	2.5-5.0				<0.27												
32-1	2.5-5.0				<0.27												
33-1	2.5-5.0								0.4								
34-1		280			<10 chc												
35-1		<10			<10 chc												
36-1	PT-1 0-2.5		.06	Organo Halogens													
	PT-2 2.5-5.0		.05	Organo Halogens													
	PT-3 5.0-7.5		.09	Organo Halogens													
	PT-4 7.5-10		.04	Organo Halogens													
37-1	PT-1 0-2.5		.03	Organo Halogens													
	PT-2 2.5-5		.03	Organo Halogens													
	PT-3 5-7.5		.03	Organo Halogens													
	PT-4 7.5-10		.01	Organo Halogens													
38-1	PT-1 0-2.5		.08	Organo Halogens													
	PT-2 2.5-5		.02	Organo Halogens													
	PT-3 5-7.5		.03	Organo Halogens													
	PT-4 7.5-10		.06	Organo Halogens													
39-1	PT-1 0.0-2.5		.05	Organo Halogens													
	PT-2 2.5-5		.03	Organo Halogens													
	PT-3 5-7.5		.05	Organo Halogens													
	PT-4 7.5-10		.03	Organo Halogens													
40-1	PT-1 0-2.5		.06	Organo Halogens													
	PT-2 2.5-5		.07	Organo Halogens													
	PT-3 5-7.5		.02	Organo Halogens													
	PT-4 7.5-10		.03	Organo Halogens													
41-1	H_2O -		<.01	Organo Halogens													
42-1	H_2O -		<.01	Organo Halogens													
43-1	PT-1 0-2.5		.03	Organo Halogens													
	PT-2 2.5-4		.03	Organo Halogens													
	PT-3 4-6.5		.03	Organo Halogens													
	PT-4 6.5-9		.02	Organo Halogens													
44-1	PT-1 0-1.5		.05	Organo Halogens													
	PT-2 1.5-4		.04	Organo Halogens													
	PT-3 4-6.5		.04	Organo Halogens													
	PT-4 6.5-9		.02	Organo Halogens													
45-1	PT-1 0-2.5		.02	Organo Halogens													
	PT-2 1.5-4		.04	Organo Halogens													
	PT-3 4-6.5		.04	Organo Halogens													
	PT-4 6.5-9		.03	Organo Halogens													
	PT-5 9-11.5		.02	Organo Halogens													

TABLE 1-2 PESTICIDES (PPB)

Index No.	DEPTH	PCB AROCLOR 1254	PCB OTHER	CHLORINATED HYDROCARBON PEST. LINDANE	BHC	DIELDRIN	TOXAPHENE	P_1P-DDE	O_1P-DDE	P_1P-DDD	P_1P-DDT	O_1P-DDT	HEPTACHLOR	HEPTACHLOR LIKE	ALDRIN	ENDRIN	CHLORDANE
27-2	SURF.	63.4						3.33	2.50	3.33	6.67						
28-2	SURF.	65.6						3.33	1.90	1.80	1.50						
29-2	0-.5	230	90		10 chc												
	3-3.5	490	300														
30-2	0-.5	220	60		10 chc												
31-2	0-.5	240	120		10 chc												
32-2	0-.5	220	60		10 chc												
33-2	0-.5	180	60		10 chc												
34-2	0-.5	230	130		10 chc												
35-2	0-.5	40	80		10 chc												
36-2	0-.5	40	110		10 chc												
37-2	0-.5	50	190		10 chc												
38-2	0-.5	40	90		10 chc												
39-2	0-.5	80	190		10 chc												
40-2	0-.5	50	130		10 chc												
43-2	0-.5				300 chc												
44-2	0-.5				100 chc												
45-2	0-.5				10 chc												
46-2	0-.5				260 chc												
47-2	0-.5				520 chc												
48-2	0-.5				200 chc												
49-2	0-.5				230 chc												
50-2	0-.5				220 chc												
51-2	0-.5				190 chc												
52-2	0-.5				100 chc												
153-2	0.0-2.5	.04	ORGANO	HALOGENS													
	2.5-5.0	.06	"	"													
	5.0-7.5	.04	"	"													
	7.5-10.0	.03	"	"													
154-2	0.0-2.5	.08	"	"													
	2.5-5.0	..05	"	"													
155-2	0.0-2.5	.05	"	"													
	2.5-5.0	.07	"	"													
	5.0-7.5	.10	"	"													
156-2	0.0-2.5	.03	"	"													
157-2	0.0-2.5	.02	"	"													
	2.5-5.0	.03	"	"													
158-2	0.0-2.5	.04	"	"													
	2.5-5.0	.05	"	"													
159-2	0.0-2.5	.02	"	"													
	2.5-5.0	.07	"	"													
160-2	0.0-2.5	.03	"	"													
161-2	0.0-2.5	.03	"	"													
162-2	WATER	<.01	"	"													
56-2	0-2.5		<10		<1.0 CHC												
	2.5-5		<10		<1.0 "												
	5-7.5		<10		<1.0 "												
	8-10.5		<10		<1.0 "												
	13.5-15.5		<10		<1.0 "												
	15.5-18.5		<10		<1.0 "												
57-2	0-2.5		<10		<1.0 CHC												
	5-6.3		<10		<1.0 "												
	10-11.5		<10		<1.0 "												
	15-16.3		<10		<1.0 "												
	20-21.5		<10		<1.0 "												
	25-26.3		<10		<1.0 "												
	32.5-34.5		<10		<1.0 "												
	37.5-39		<10		<1.0 "												
58-2	0-2.5		300		<1.0 CHC												
	11.5-14.0		<10		<1.0 "												
	23.5-25.5		<10		<1.0 "												
59-2	0-2.5		<10		<1.0 CHC												
	22.5-25		<10		<1.0 "												
	41-41.5		<10		<1.0 "												
69-2	0-.5		0.68	<0.01	<0.01	0.02	<0.01	<0.01		0.16	<0.01		<0.01		<0.01	<0.01	<0.01
	.5-2		6.06	<0.01	<0.01	0.01	<0.01	<0.01		1.4	<0.01		<0.01		<0.01	<0.01	<0.01
	2-3.5		0.14	<0.01	<0.01	0.02	<0.01	0.24		0.47	3.4		<0.01		<0.01	<0.01	<0.01
70-2	0-.75	70								0.6	1.0						
	.75-1.5	22								-	2.0						
71-2	0-.75	41								-	0.9						
	.75-1.5	27						1.1		0.1	4.2						
72-2	0-.75	36						-		0.1	1.3						
	.75-1.5	63						0.4		-	0.5						
73-2	0-.75	38						-		-	0.7						
	.75-1.5	36						0.1		0.1	0.6						
74-2	0-.75	31						0.1		0.2	0.3						
	.75-1.5	67						0.1		-	0.4						
75-2	0-.75	37						0.4		-	0.1						
	.75-1.5	114						0.[illegible]		-	0.3						
167-2	WATER				0.14												
167-2	PT-1																
	0-2.5	1.7															
	PT-2																
	2.5-5	1.0			0.04												
	PT-3																
	5-7.5	2.3			0.06						<.001						
168-2	PT-1																
	0-2.5	2.6									<.001						
	PT-2																
	2.5-5	1.8			0.09												
	PT-3&4																
	5-10	2.0			0.11												
	PT-5&6																
	10-15	2.9			0.03												
	PT-7&8																
	15-19.8	3.2			0.07						<.001						
	PT-9&10																
	20-24	2.0															
	PT-11&12																
	25-29.2	3.9									<.001						

TABLE 1-2 PESTICIDES (PPB)

Index No.	DEPTH	PCB: AROCLOR 1254	PCB: OTHER	CHLORINATED HYDROCARBON PEST.: LINDANE	BHC	DIELDRIN	TOXAPHENE	P,P-DDE	O,P-DDE	P,P-DDD	P,P-DDT	O,P-DDT	HEPTACHLOR	HEPTACHLOR LIKE	ALDRIN	ENDRIN	CHLORDANE
169-2	PT-1 0-1	3.1									<.001						
	PT-2&3 2.5-7.5	3.5			0.11												
	PT-4&5 7.5-12.5	3.4									<.001						
170-2	PT-1 0-2.5	0.9									.008						
	PT-2 2.5-5	<0.4									<.001						
171-2	PT-1 0-2.5	2.8			0.07						<.001						
	PT-2&3 2.5-6.6	3.2									.010						
	PT-4&5 7.5-12.5	2.6															
172-2	PT-1 0-1.5	3.5															
	PT-2 2.5-3.8	3.7			0.10												
	PT-3 5-7.3	4.3			0.11												
	PT-4 7.5-10	3.3			0.19						<.001						
173-2	PT-1 0-2.5	3.1			0.11						<.001						
	PT-2 2.5-5	3.4									.006						
	PT-3 5-7.5	3.1									<.001						
	PT-4 7.5-8.9	0.8									.004						
174-2	PT-1 0-2.5	3.7									<.001						
	PT-2&3 2.5-7.5	3.4			0.14												
	PT-4&5 7.5-12.1	4.0									.009						
175-2	PT-1 0-2.5	4.1															
	PT-2 2.5-5	3.6															
	PT-3&4 5-9.7	3.1															
176-2	PT-1 0-2.5	3.2															
	PT-2 2.5-5	3.9															
	PT-3 5-7.5	3.0															
177-2	PT-1 0-2.5	3.3		.019							.008						
	PT-2 2.5-5	3.9															
	PT-3 5-7.5	1.7															
	PT-4 7.5-10	0.8		.006													
	PT-5 10-12.5	0.6															
178-2	PT-1 0-2.5	0.7															
	PT-2 2.5-5	1.1															
	PT-3 5-7.5	1.1									.007						
179-2	PT-1 0-2.5	1.0															
	PT-2&3 2.5-6.4	1.2									.009						
	PT-4&5 6.4-10.4	0.9									.010						
180-2	PT-1 0-2.5	0.6									.009						
	PT-2 2.5-5	0.9									.019						
	PT-3&4 5-10	0.6									.005						
181-2	PT-1 0-2.5	0.5									.008						
	PT-2 2.5-5	0.6									.006						
	PT-3&4 5-10	0.8															
	PT-5&6 10-15	0.7									.007						
182-2	PT-1 0-2.5	0.8			0.2						.008						
	PT-2 2.5-5	0.6									.009						
	PT-3&4 5-10	1.0			0.22						.012						
	PT-5&6 10-15	0.9									.013						
183-2	PT-1 0-2.5	1.2									.017						
	PT-2 2.5-5	1.9															
	PT-3 5-7.5	1.2															
	PT-4&5 7.5-12.5	1.0															

TABLE 1-2 PESTICIDES (PPB)

Index No.	DEPTH	PCB		CHLORINATED HYDROCARBON PEST.													
		AROCLOR 1254	OTHER	LINDANE	BHC	**DIELDRIN**	TOXAPHENE	P_1P-DDE	O_1P-DDE	P_1P-DDD	P_1P-DDT	O_1P-DDT	HEPTACHLOR	HEPTACHLOR LIKE	ALDRIN	ENDRIN	CHLORDANE
184-2	PT-1 0-2.5		<.05	ORGANO	HALOGENS												
185-2	PT-1 0-2.5		<.05	"	"												
186-2	PT-1 0-1.5		<.05	"	"												
187-2	PT-1 0-1.5		<.05	"	"												
188-2	PT-1 0-2.5		<.05	"	"												
189-2	PT-1 0-2.5		<.05	"	"												
191-2	PT-1 0-2.0		<.05	"	"												
192-2	PT-1 0-2.5		<.05	"	"												
193-2	PT-1 0-2.5		< .05	ORGANO	HALOGENS												
194-2	PT-1 0-2.5		< .05	"	"												
198-2	H_2O		< .05	"	"												
200-2	0.0-2.5	.02		"	"												
	2.5-5.0	.02		"	"												
	5.0-7.5	.03		"	"												
201-2	0.0-2.5	.02		"	"												
	2.5-5.0	.04		"	"												
	5.0-7.5	.03		"	"												
202-2	0.0-2.5	.02		"	"												
	2.5-5.0	.06		"	"												
	5.0-7.5	.03		"	"												
	7.5-10.0	.02															
203-2	0.0-2.5	.02		"	"												
	2.5-5.0	.03		"	"												
	5.0-7.5	.03		"	"												
	7.5-10.0	.02		"	"												
	10.0-12.5	.07		"	"												
204-2	0.0-2.5	.03		"	"												
	2.5-5.0	.02		"	"												
	5.0-7.5	.07		"	"												
	7.5-10.0	.02		"	"												
205-2	0.0-2.5	.02		"	"												
	2.5-5.0	.03		"	"												
	5.0-7.5	.02		"	"												
	7.5-10.0	.04		"	"												
	10.0-12.5	.03		"	"												
	12.5-15.0	.02		"	"												
	15.0-17.5	.03		"	"												
206-2	0.0-2.5	.02		"	"												
	2.5-5.0	.02		"	"												
	5.0-7.5	.04		"	"												
	7.5-10.0	.02		"	"												
77-2	SURF.				2.42			0.53	2.0	2.0	0.8						
78-2	0-.5	90															
79-2	0-.5	120			<10 CHC												
80-2	0-.5	110			<10 "												
81-2	0-.5	70			<10 "												
82-2	0-.5	70			<10 "												
83-2	0-.5	50			<10 "												
84-2	0-.5	70			<10 "												
85-2	0-.5	70			<10 "												
86-2	SURF.	80			<10 "												

TABLE 1-2 PESTICIDES (PPB)

Index No.	DEPTH	PCB		CHLORINATED HYDROCARBON PEST.													
		AROCLOR 1254	OTHER	LINDANE	BHC	DIELDRIN	TOXAPHENE	P_1P-DDE	O_1P-DDE	P_1P-DDD	P_1P-DDT	O_1P-DDT	HEPTACHLOR	HEPTACHLOR LIKE	ALDRIN	ENDRIN	CHLORDANE
207-2	WATER		.01	ORGANO	HALOGENS												
208-2	WATER	2.2						0.016			.019						
209-2	PT-1 0-1.5		.02	ORGANO	HALOGENS												
	PT-2 1.5-3.5		.01	"	"												
	PT-3&4 4-7	1.0			0.02			.009			.014						
	PT-5&6 7-10	0.5			0.003			.009			.017						
	PT-7&8 10-13	0.5			0.02			.008			.012						
210-2	PT-1&2 0-3		.01	ORGANO	HALOGENS												
	PT-3&4 3-6	3.0			0.02			.007			.011						
	PT-5&6 6-9	0.6			0.02			.007			.013						
	PT-7&8 9-12	1.3			0.02			.008			.012						
211-2	PT-1 0-1.5		.01	ORGANO	HALOGENS												
	PT-2 1.5-3.3		.03	"	"												
	PT-3 3.3-4.6		.01	"	"												
	PT-4 4.6-7.1		.02	"	"												
	PT-5 7.1-8.6		.02	"	"												
212-2	PT-1 0-2.5		.01	"	"												
	PT-2 2.5-5		.02	"	"												
	PT-3 5-7.5		.01	"	"												
213-2	PT-1 0-2.5		.01	"	"												
	PT-2 2.5-5.5	3.4			0.02			.008			.009						
	PT-3 5.5-8.5	0.2			0.01			.003			.007						
214-2	PT-1 0-2.3		.02	ORGANO	HALOGENS												
	PT-2&3 2.5-5.4	1.1			0.02			.013			.21						
	PT-4&5 5.4-8.5	2.3		0.05				.014									
	PT-6&7 8.5-11.2	0.5		0.04				.013			.020						
215-2	PT-1 0-2.3		.02	ORGANO	HALOGENS												
	PT-2 2.5-4.5		.01	"	"												
	PT-3&4 5-8	1.1			.06			.012			.015						
	PT-5&6 8-11	2.1			.05			.012			.017						
	PT-7&8 11-14	1.9			.08			.010			.012						
216-2	PT-1 0-2.3		.02	ORGANO	HALOGENS												
	PT-2 2.5-5		.02	"	"												
	PT-3 5-7.5		.03	"	"												
	PT-4 7.5-10		.01	"	"												
	PT-5 10-12.1		.01	"	"												
217-2	PT-1 0-2.5		.02	"	"												
	PT-2 2.5-5		.01	"	"												
	PT-3 5-7.5		.02	"	"												
	PT-4 7.5-10		.03	"	"												
	PT-5 10-12.1		.02	"	"												
218-2	PT-1 0-1.5		.01	"	"												
	PT-2&3 1.5-5.5	1.7			.08			.016			.022						
	PT-4&5 5.5-7.5	1.7			-			.015			.018						
	PT-6&7 7.5-10.5	1.1			-			.011			.014						
145-2		0.12	ORGANO	HALOGENS													
146-2		0.05	"	"													
147-2		0.03	"	"													
148-2		0.04	"	"													
149-2	0-2.5	0.07	"	"													
	2.5-5	0.02	"	"													
150-2	0-2.5	0.03	"	"													
	2.5-5	0.03	"	"													
151-2	0-2.5	0.02	"	"													
	2.5-5	0.07	"	"													
152-2	0-2.5	0.08	"	"													
	2.5-5	0.16	"	"													

TABLE 1-2 PESTICIDES (PPB)

Index No.	DEPTH	PCB AROCLOR 1254	PCB OTHER	CLORINATED HYDROCARBON PEST. LINDANE	BHC	DIELDRIN	TOXAPHENE	P_1P-DDE	O_1P-DDE	P_1P-DDD	P_1P-DDT	O_1P-DDT	HEPTACHLOR	HEPTACHLOR LIKE	ALDRIN	ENDRIN	CHLORDANE
5-3	0-.75	12								1.2							
	.75-1	28								2.0	0.5						
6-3	0-.75		0.13	<0.01	< 0.01	<0.01	< 0.01	<0.01		< 0.01	< 0.01		< 0.01		< 0.01	< 0.01	< 0.01
	.75-1		0.19	<0.01	< 0.01	<0.01	< 0.01	<0.01		< 0.01	< 0.01		< 0.01		< 0.01	< 0.01	< 0.01
7-3	0-.75		0.13	<0.01	< 0.01	<0.01	< 0.01	<0.01		< 0.01	< 0.01		< 0.01		< 0.01	< 0.01	< 0.01
	.75-1		<0.04	<0.01	< 0.01	<0.01	< 0.01	<0.01		< 0.01	< 0.01		< 0.01		< 0.01	< 0.01	< 0.01
8-3	0-.75	22						0.3			0.3						
	.75-1	8						0.5			0.5						
9-3	0-.75		<0.04	<0.01	< 0.01	<0.01	< 0.01	<0.01		< 0.01	< 0.01		< 0.01		< 0.01	< 0.01	< 0.01
	.75-1		0.15	<0.01	< 0.01	<0.01	< 0.01	<0.01		< 0.01	< 0.01		< 0.01		< 0.01	< 0.02	< 0.01
10-3	0-.75		0.1	<0.01	< 0.01	<0.01	< 0.01	<0.01		< 0.01	< 0.01		< 0.01		< 0.01	< 0.01	< 0.01
	.75-1		0.12	<0.01	< 0.01	<0.01	< 0.01	<0.01		< 0.01	< 0.01		< 0.01		< 0.01	< 0.01	< 0.01
11-3	0-.75	15									0.2						
	.75-1	24									-						
12-3	0-.75		0.07	<0.01	< 0.01	<0.01	< 0.01	<0.01		< 0.01	< 0.01		< 0.01		< 0.01	< 0.01	< 0.01
	.75-1		0.15	<0.01	< 0.01	<0.01	< 0.01	<0.01		< 0.01	< 0.01		< 0.01		< 0.01	< 0.01	< 0.01
13-3	0-.75		0.05	<0.01	< 0.01	<0.01	< 0.01	<0.01		< 0.01	< 0.01		< 0.01		< 0.01	< 0.01	< 0.01
	.75-1.5		0.1	<0.01	< 0.01	<0.01	< 0.01	<0.01		< 0.01	< 0.01		< 0.01		< 0.01	< 0.01	< 0.01
14-3	0-.75	6									0.5						
	.75-1.5	10									-						
15-3	0-.75		0.09	<0.01	< 0.01	< 0.01	< 0.01	<0.01		< 0.01	< 0.01		< 0.01		< 0.01	< 0.01	< 0.01
	.75-1.5		0.16	<0.01	< 0.01	< 0.01	< 0.01	<0.01		< 0.01	< 0.01		< 0.01		< 0.01	< 0.01	< 0.01
16-3	0-.75		0.16	<0.01	< 0.01	< 0.01	< 0.01	<0.01		< 0.01	< 0.01		< 0.01		< 0.01	< 0.01	< 0.01
	.75-1.5		0.16	<0.01	< 0.01	< 0.01	< 0.01	<0.01		< 0.01	< 0.01		< 0.01		< 0.01	< 0.01	< 0.01
17-3	0-.75	30								0.3	0.4						
	.75-1.5	42						0.6		1.0	0.6						
18-3	0-.75		0.08	<0.01	< 0.01	< 0.01	< 0.01	<0.01		< 0.01	< 0.01		< 0.01		< 0.01	< 0.01	< 0.01
	.75-1.5		0.2	<0.01	< 0.01	< 0.01	< 0.01	<0.01		< 0.01	< 0.01		< 0.01		< 0.01	< 0.01	< 0.01
19-3	0-.75		0.13	<0.01	< 0.01	< 0.01	< 0.01	<0.01		< 0.01	< 0.01		< 0.01		< 0.01	< 0.01	< 0.01
	.75-1.5		0.12	<0.01	< 0.01	< 0.01	< 0.01	<0.01		< 0.01	< 0.01		< 0.01		< 0.01	< 0.01	< 0.01
20-3	.75-1.5									0.8							
21-3	0-.75		0.09	<0.01	< 0.01	< 0.01	< 0.01	<0.01		0.02	< 0.01		< 0.01		< 0.01	< 0.01	< 0.01
	.75-1.5		0.06	<0.01	< 0.01	< 0.01	< 0.01	<0.01		0.03	< 0.01		< 0.01		< 0.02	< 0.01	< 0.01
22-3	0-.75		0.06	<0.01	< 0.01	< 0.01	< 0.01	<0.01		0.01	< 0.01		< 0.01		< 0.01	< 0.01	< 0.01
	.75-1.5		0.10	<0.01	< 0.01	< 0.01	< 0.01	<0.01		0.03	< 0.01		< 0.01		< 0.01	< 0.01	< 0.01
151-3	PT-1 0-2.5			0.1	ORGANO	HALOGENS											
	PT-2 2.5-5			0.1	"	"											
	PT-3 5-7.5			0.1	"	"											
	PT-4 7.5-10			1.2	"	"											
152-3	PT-1 0-2.5			0.3	ORGANO	HALOGENS											
	PT-2 2.5-5			0.8	"	"											
	PT-3 5-7.5			3.3	"	"											
	PT-4																
153-3	PT-1 0-2.5			0.6	"	"											
	PT-2 2.5-5			0.5	"	"											
	PT-3 5-7.5			2.2	"	"											
	PT-4 7.5-10			5.2	"	"											
	PT-5 10-12.5			2.8	"	"											
154-3	PT-1 0-2.5			0.4	"	"											
	PT-2 2.5-4			<0.1	"	"											
155-3	PT-1 0-2.5			1.6	"	"											
156-3	PT-1 0-2.5			5.3	"	"											
	PT-2 2.5-5			<0.1	"	"											
157-3	PT-1 0-2.5			2.6	"	"											
	PT-2 2.5-5			2.5	"	"											
158-3	PT-1 0-2.5			<0.1	"	"											
	PT-2 2.5-5			5.1	"	"											
	PT-3 5-7.5			5.7	"	"											
	PT-4 7.5-10			0.1	"	"											
74-3	0-.5	4.7									0.011						
75-3	0-.5	3.9									0.008						
76-3	0-.5	3.7			0.15						0.011						
77-3	0-.5	6.0			0.21												
78-3	0-.5	4.2									<0.001						
79-3	0-.5	4.0									0.003						
101-3	0-.6	24															
	3.2-3.8	25															
	6.9-7.5	24															
102-3	0-.6	9															
	3.2-3.8	8															
	14.4-15	10															
103-3	0-2.5	1.3									0.001						
104-3	0-2.5	0.3			0.087						-						
105-3	0-2.5	0.3									<0.001						
106-3	0-2.5	0.9			.021						0.006						
107-3	0-2.5	0.2									0.001						
108-3	0-2.5	0.7			.042						0.002						

TABLE 1-2 *PESTICIDES (PPB)*

Index No.	DPETH	PCB AROCLOR 1254	PCB OTHER	LINDANE	BHC	DIELDRIN	TOXAPHENE	P,P-DDE	O,P-DDE	P,P-DDD	P,P-DDT	O,P-DDT	HEPTACHLOR	HEPTACHLOR LIKE	ALDRIN	ENDRIN	CHLORDANE
141-3	J-1 H_2O	1.6		0.9	2.3									8.3			
	PJ-1 0-.4	< 1.0															
	PJ-9 3.4-3.8	15		0.22	0.3												
	PJ-18 7.1-7.5	7		0.25	0.4												
142-3	J-1 0-.5	1.0		0.09													
	PT-1 0-.5	27						0.59			1.26			1.3			
	PT-7 3.8-4.3	16															
	PT-12 6.8-7.5	19						0.41									
143-3	PT-1	24		0.39													
144-3	J-1 H_2O	1.0		1.07										1.0			
	PT-1	10		0.28	3.8												
145	J-1 H20	1.3		0.13										0.9			
	PT-1 0-.5	27															
	PT-8 4.5-5	2															
	PT-16 8.7-10	14															
10-4	SURF.				< 25,000	Hydrocarbons											
11-4	SURF.				25,000	"											
12-4	SURF.				25,000	"											
25-4	H_2O SITE 1	0.4															
	H_2O SITE 2	0.4															
26-4	0.0-1.7	1.2			0.22												
		0.9															
27-4	0.0-2.3	0.5															
	0.7	0.7									.008						
	2.5-3.8	0.5			0.19						.009						
		0.8			0.14						.012						
28-4	0.0-1.5	0.5									.008						
		0.5			.09						.008						
	1.5-3.5	-															
		0.6															
29-4	0.0-2.5	0.9									.002						
		0.7															
	2.5-4.7	0.6			.23						.004						
		0.6			.05						<.001						
	5.0-71.	0.5															
		0.6															
	7.5-8.6	0.6															
		0.6			.06												
30-4	0.0-2.5	0.6									.003						
		0.4									.003						
31-4	0.0-2.3	0.4															
		0.3															
	2.5-4.8	0.2															
		0.5									.001						
	5.0-6.5	0.9			.14						.003						
		0.5									<.001						
32-4	0.0-2.2	0.2			0.11												
		-															
	2.5-4.7	0.1															
		0.2															
33-4	0.0-2.5	0.3															
		0.3															
	2.5-5.0	0.4															
		0.3															
34-4	0.0-2.3	0.4															
		0.2															
35-4	0.4-2.4	0.4			0.07												
		0.3			0.11												
36-4	0.0-2.0	0.5															
		0.4			0.11												

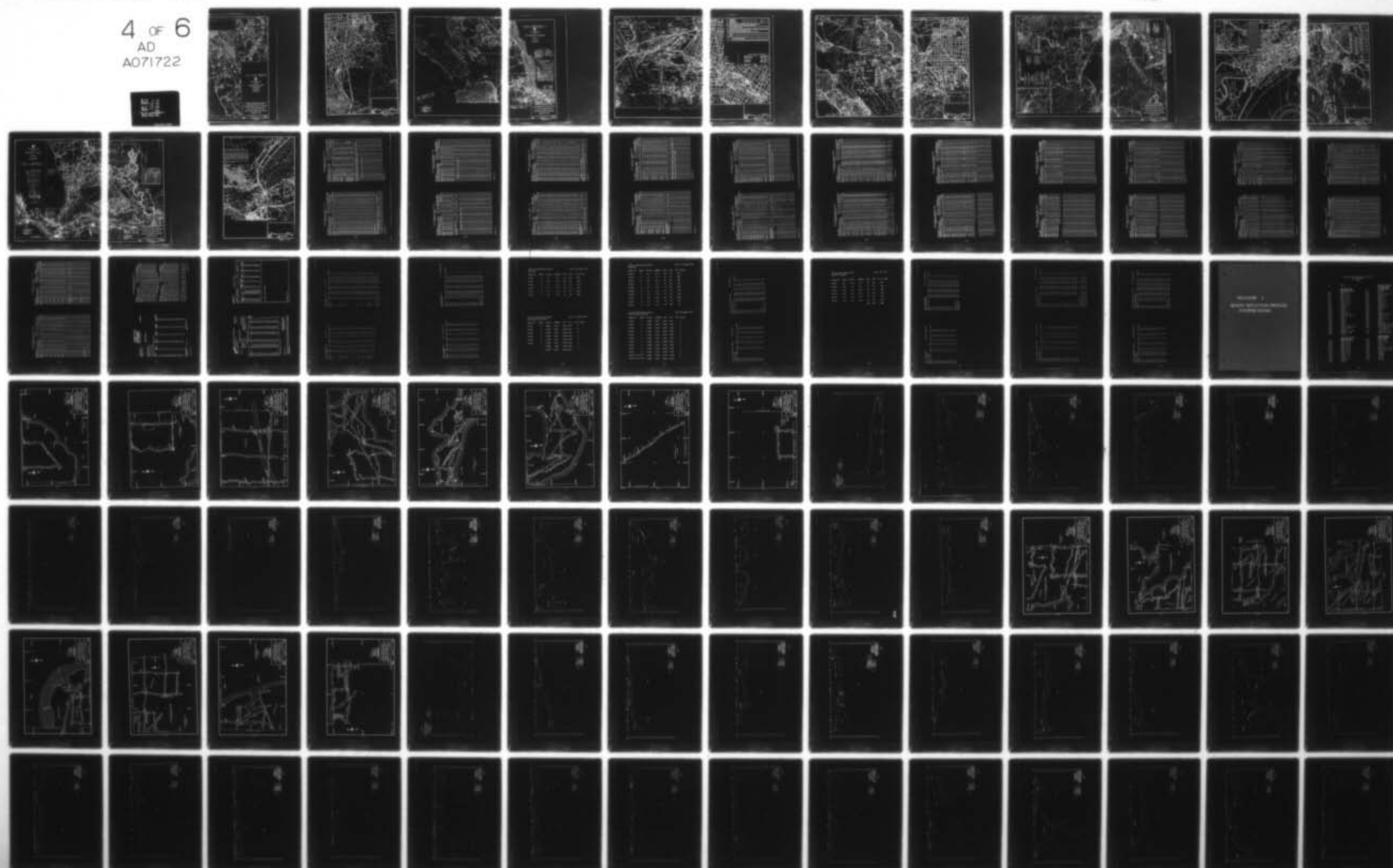
See SHEET 1a

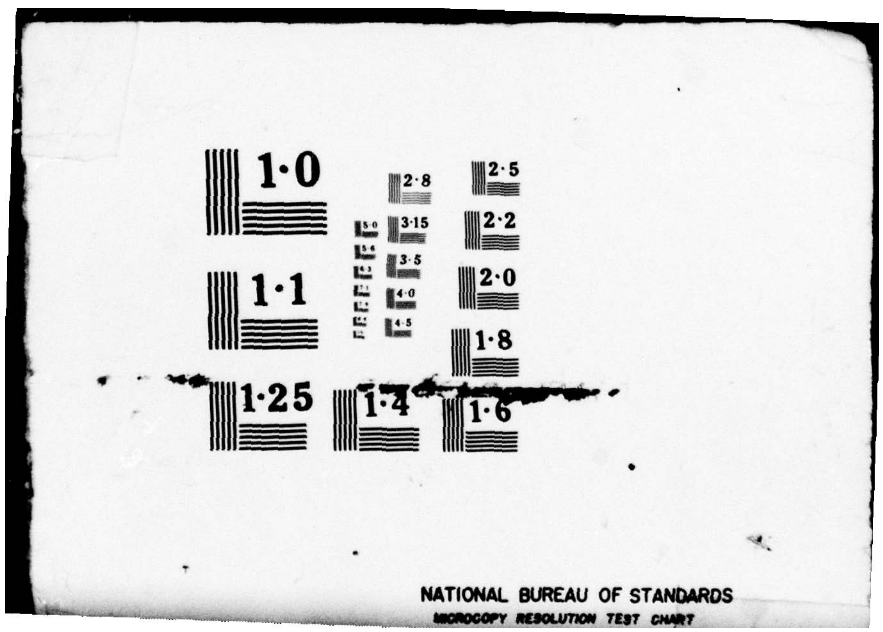
San Francisco
Bay Farm Island
San Mateo
Burlingame
LEGEND
POLLUTANT DISTRIBUTION SAMPLE LOCATION AND NUMBER
OTHER SAMPLE LOCATION AND INDEX NUMBER
APPROXIMATE SAMPLE LOCATION AND INDEX NUMBER

AD-A071 722 CORPS OF ENGINEERS SAN FRANCISCO CALIF SAN FRANCISCO--ETC F/G 13/3
DREDGE DISPOSAL STUDY. SAN FRANCISCO BAY AND ESTUARY. APPENDIX --ETC(U)
MAY 79 R M ECKER, J F SUSTAR, J HENDRICKS

UNCLASSIFIED NL

4 OF 6
AD
A071722

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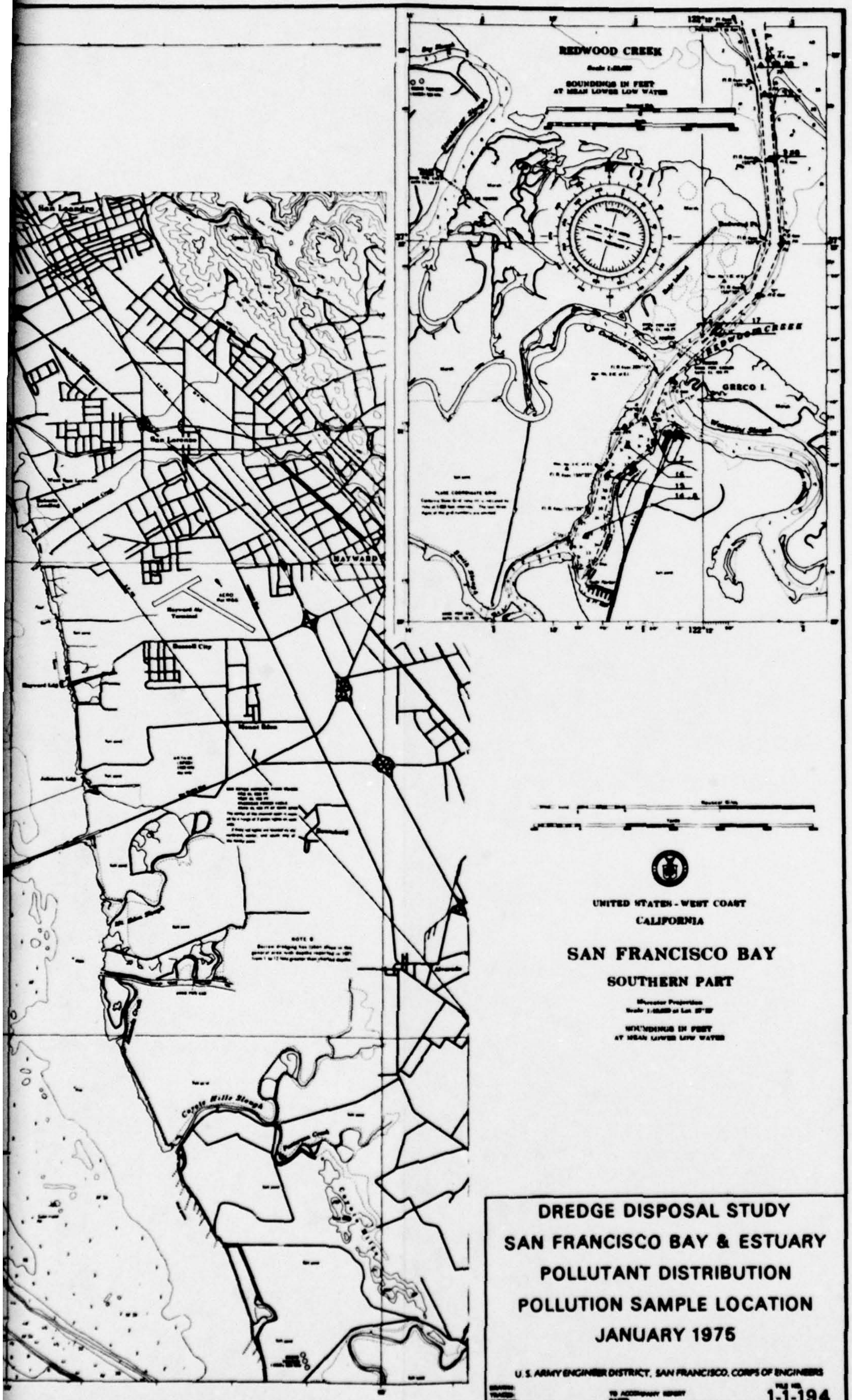
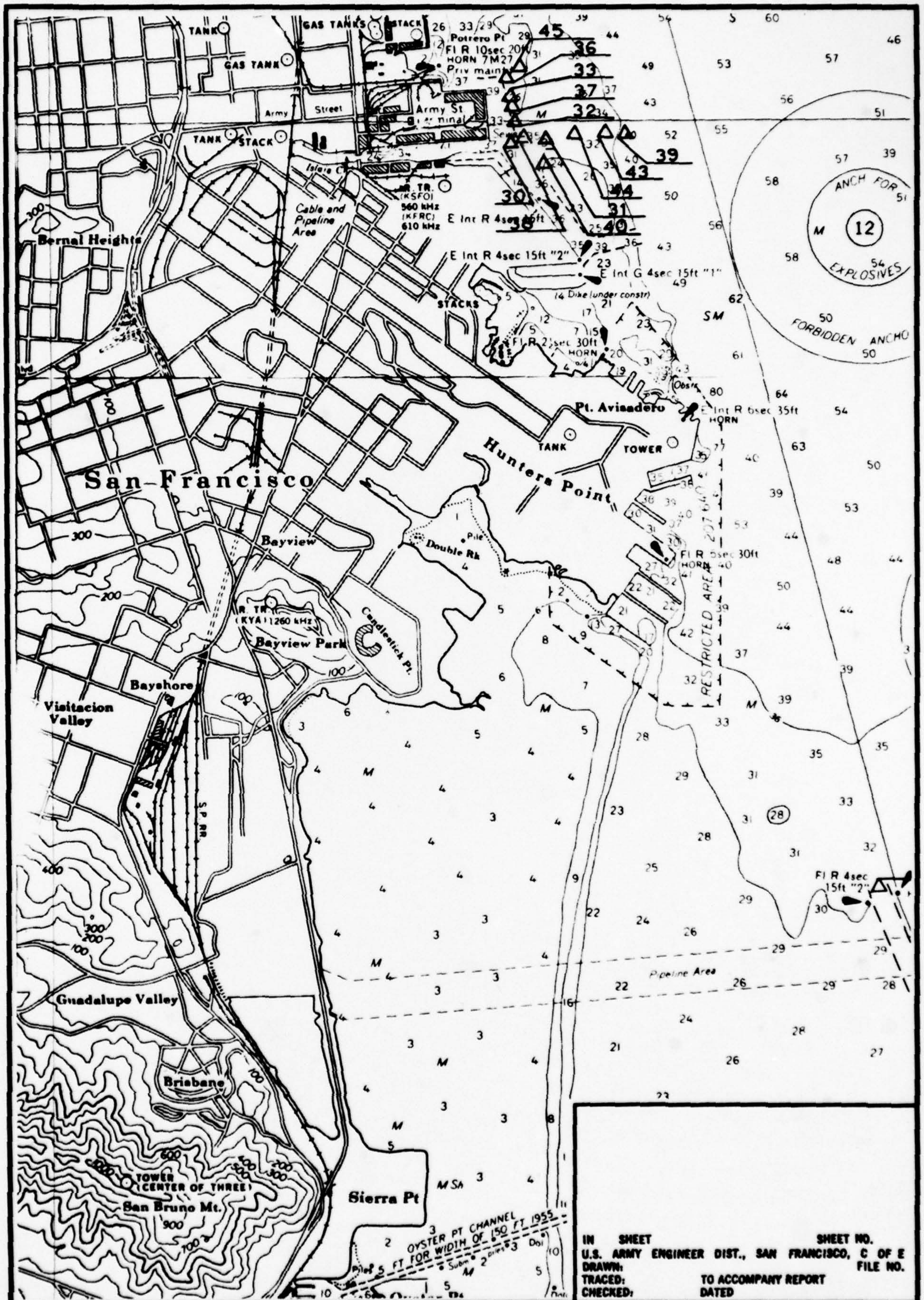
NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART


REDWOOD CREEK
SOUNDINGS IN FEET
AT MEAN LOWER LOW WATER
REDWOOD CREEK
GRECO I.
San Leandro
San Lorenzo
HAYWARD
NOTE D
Coyote Hills Slough
UNITED STATES - WEST COAST
CALIFORNIA
SAN FRANCISCO BAY
SOUTHERN PART
SOUNDINGS IN FEET
AT MEAN LOWER LOW WATER
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY & ESTUARY
POLLUTANT DISTRIBUTION
POLLUTION SAMPLE LOCATION
JANUARY 1975
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS
1-1-194

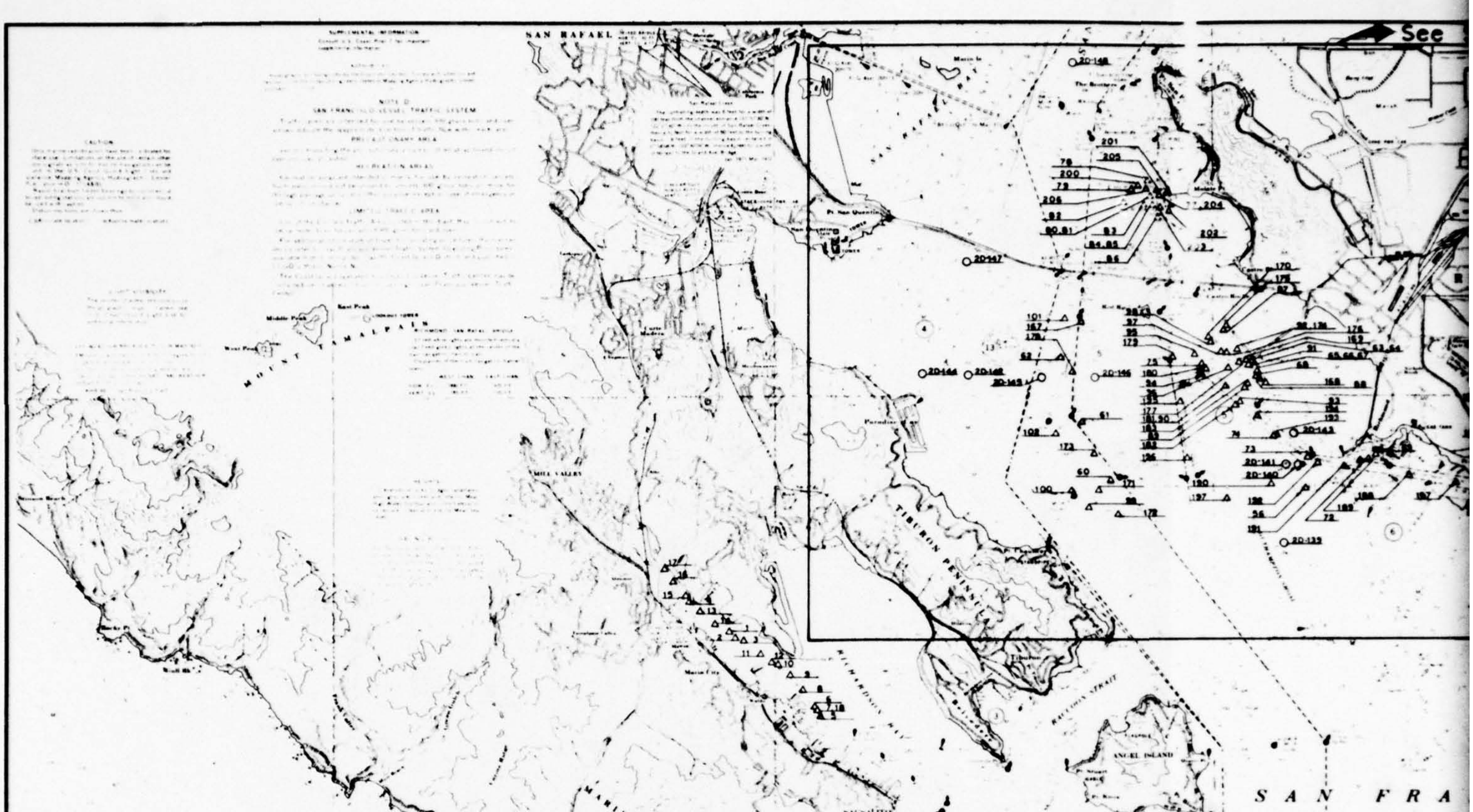
1 2

SHEET 1



TANK
GAS TANKS
STACK
GAS TANK
Potrero Pt
Army Street
Army St
TANK
STACK
Cable and Pipeline Area
560 kHz
610 kHz
Bernal Heights
E Int R 4sec 15ft "2"
E Int G 4sec 15ft "1"
STACKS
ANCH FOR EXPLOSIVES
FORBIDDEN ANCHO
Pt. Aviadero
TANK
TOWER
Hunters Point
San Francisco
Bayview
Double Rk
RESTRICTED AREA
Candlestick Pt
Bayview Park
Bayshore
Visitacion Valley
S P RR
Pipeline Area
Guadalupe Valley
Brisbane
TOWER (CENTER OF THREE)
San Bruno Mt.
Sierra Pt
OYSTER PT CHANNEL
5 FT FOR WIDTH OF 150 FT 1955
IN SHEET SHEET NO.
U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E
DRAWN: FILE NO.
TRACED: TO ACCOMPANY REPORT
CHECKED: DATED

SHEET 1a



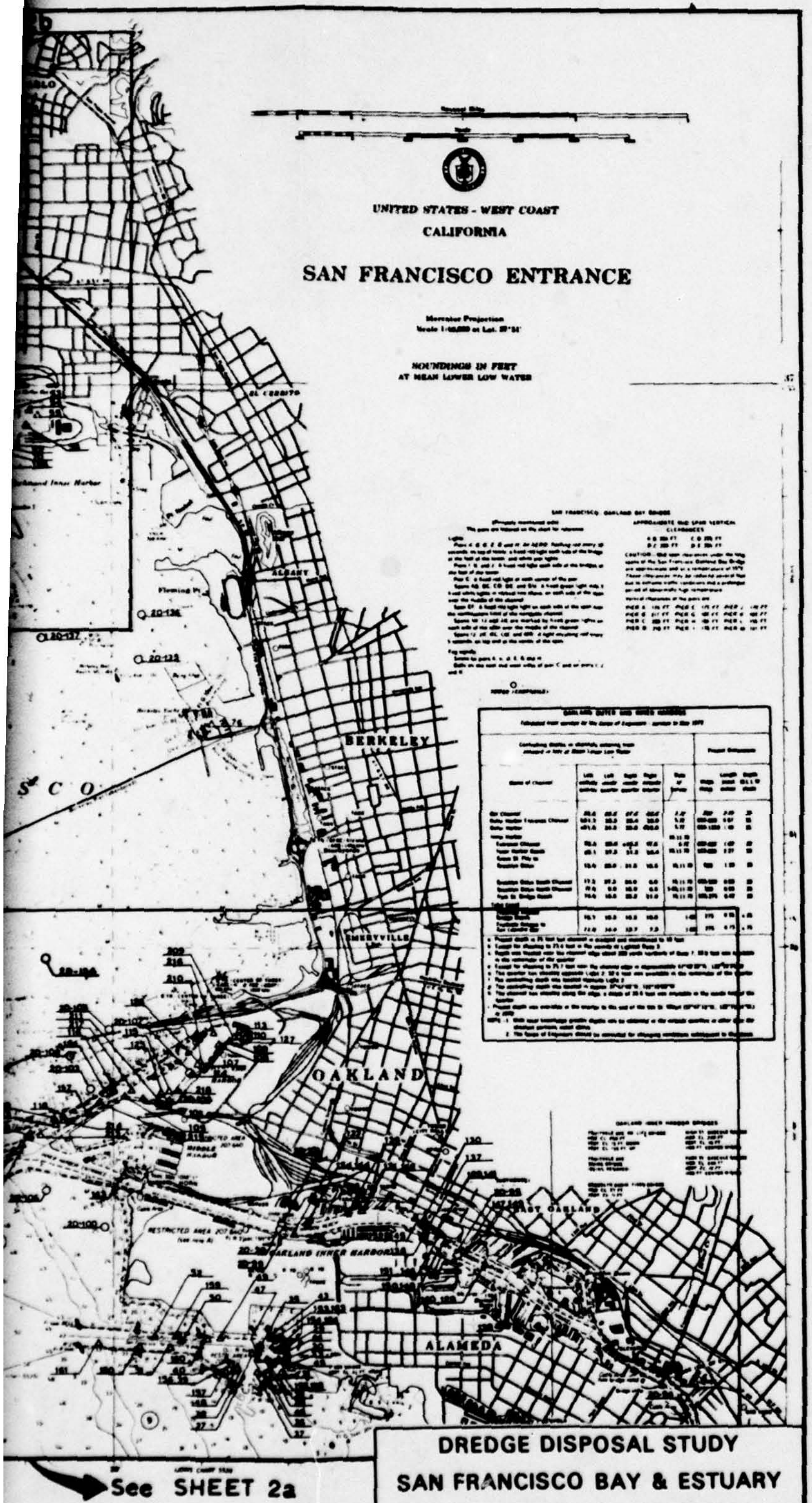
LEGEND

POLLUTANT DISTRIBUTION SAMPLE LOCATION AND NUMBER

OTHER SAMPLE LOCATION AND INDEX NUMBER

APPROXIMATE SAMPLE LOCATION AND INDEX NUMBER

1



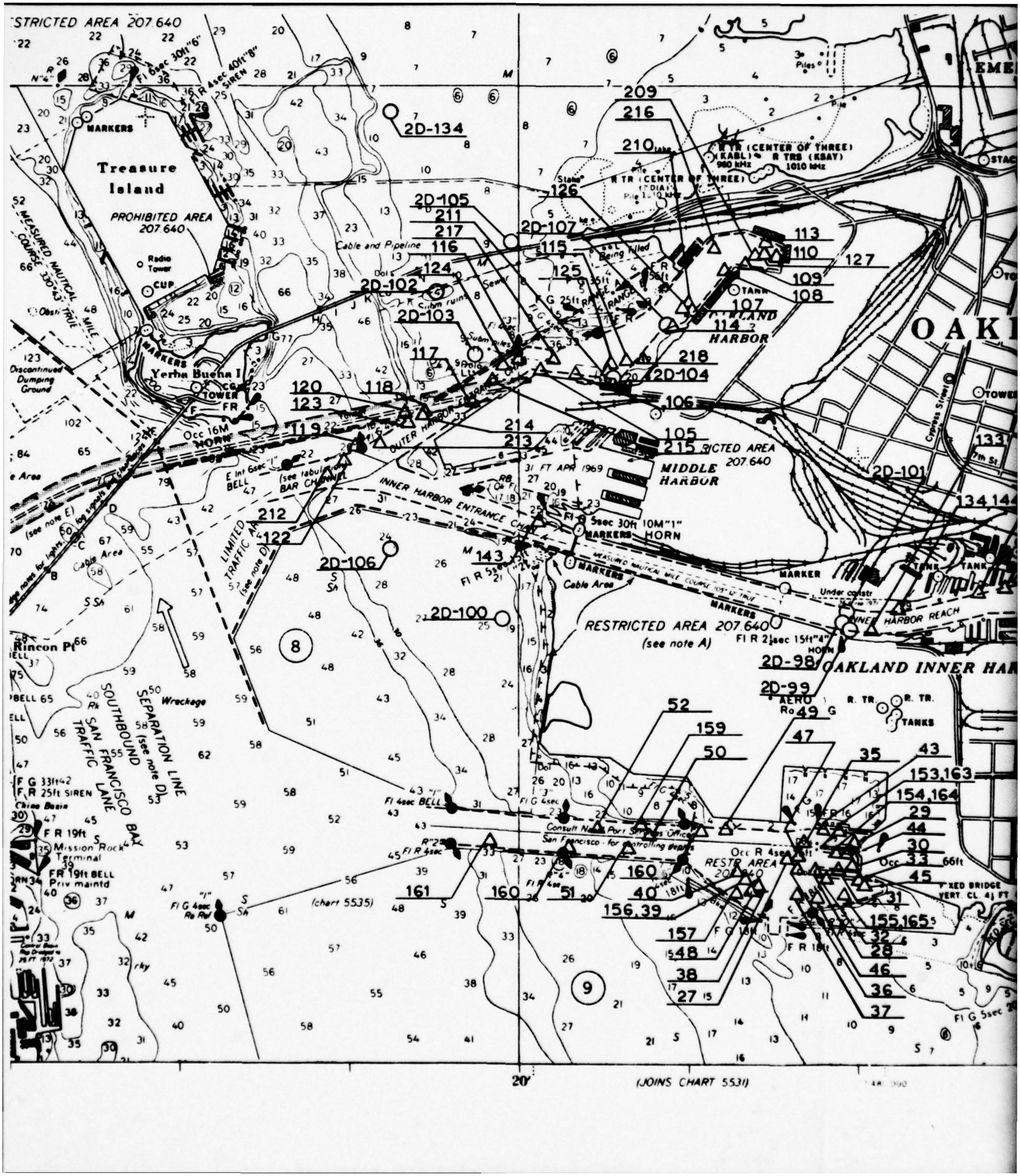
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY & ESTUARY
POLLUTANT DISTRIBUTION
POLLUTION SAMPLE LOCATION
JANUARY 1975

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS

1-1-194

SHEET 2

2

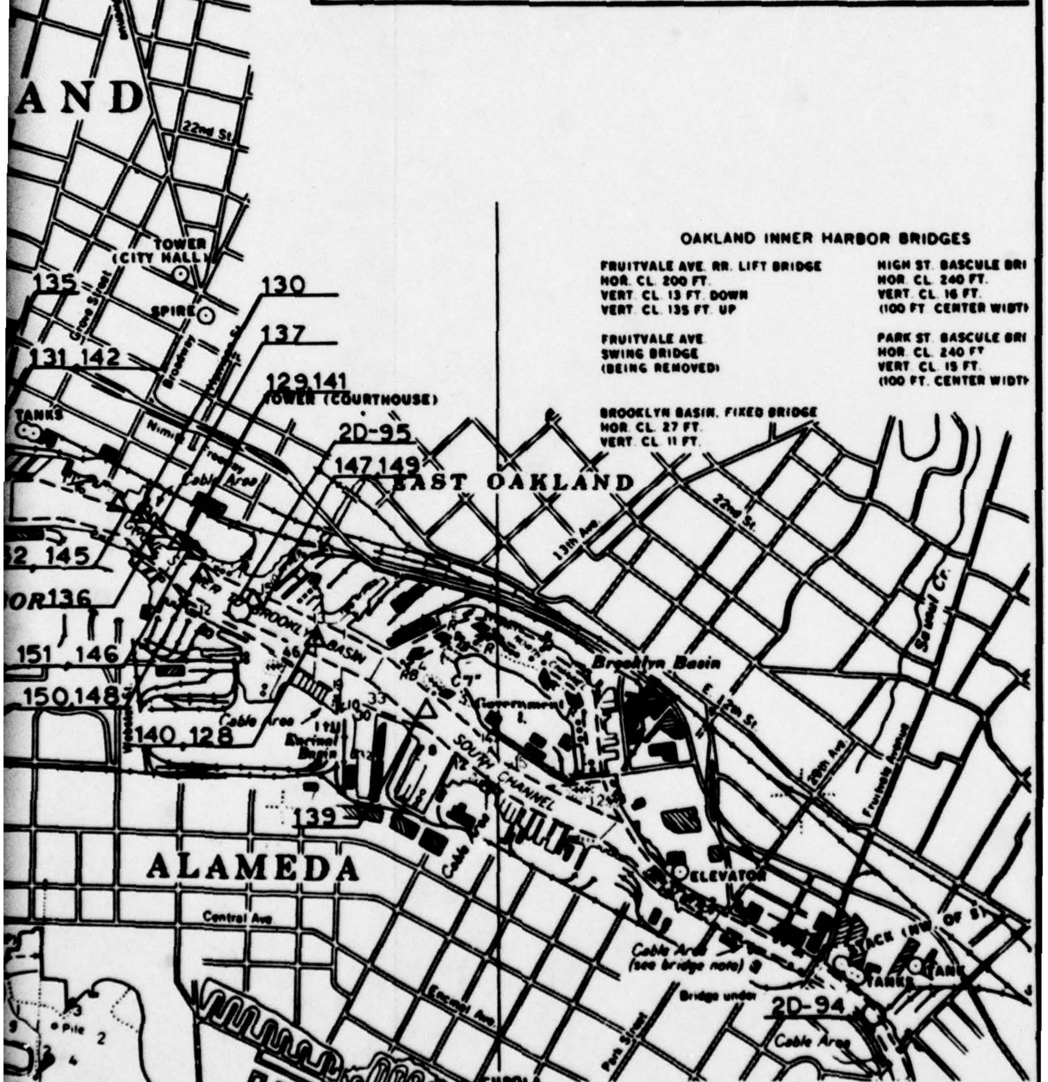


RESTRICTED AREA 207.640
Treasure Island
PROHIBITED AREA 207.640
MARKERS
Radio Tower
CUP
Yerba Buena I
TOWER
Occ 16M HORN
MEASURED NAUTICAL MILE COURSE 330°43' TRUE
Discontinued Dumping Ground
Cable and Pipeline
OUTER HARBOR
BAR CHANNEL
INNER HARBOR ENTRANCE CHANNEL
LIMITED TRAFFIC AREA (see note D)
MIDDLE HARBOR
RESTRICTED AREA 207.640
31 FT APR 1969
Fl 5sec 30ft 10M "1" HORN
Cable Area
RESTRICTED AREA 207.640 (see note A)
OAKLAND INNER HARBOR
INNER HARBOR REACH
OAKLAND
OAKLAND HARBOR
R TR (CENTER OF THREE) (KABL) 960 kHz
R TRS (KSAY) 1010 kHz
Being Filled
Rincon Pt
SOUTHBOUND SAN FRANCISCO BAY TRAFFIC LANE
SEPARATION LINE (see note D)
Wreckage
Mission Rock Terminal
China Basin
Consult Naval Port Services Office San Francisco - for controlling depths
RESTR AREA 207.640
FIXED BRIDGE VERT. CL. 4½ FT
Cypress Street
7th St
Under constr
MARKER
TANKS
AERO
(chart 5535)
2D-134
2D-105
211
217
116
124
2D-102
2D-103
117
120
123
118
119
212
122
2D-106
143
2D-100
2D-107
115
125
126
209
216
210
113
110
127
109
108
107
114
218
2D-104
106
214
213
105
215
2D-101
133
134,144
2D-98
2D-99
52
159
50
49
47
35
43
153,163
154,164
29
44
30
33
45
31
155,165
32
28
46
36
37
160
40
51
156,39
157
48
38
27
161
20'
(JOINS CHART 5531)

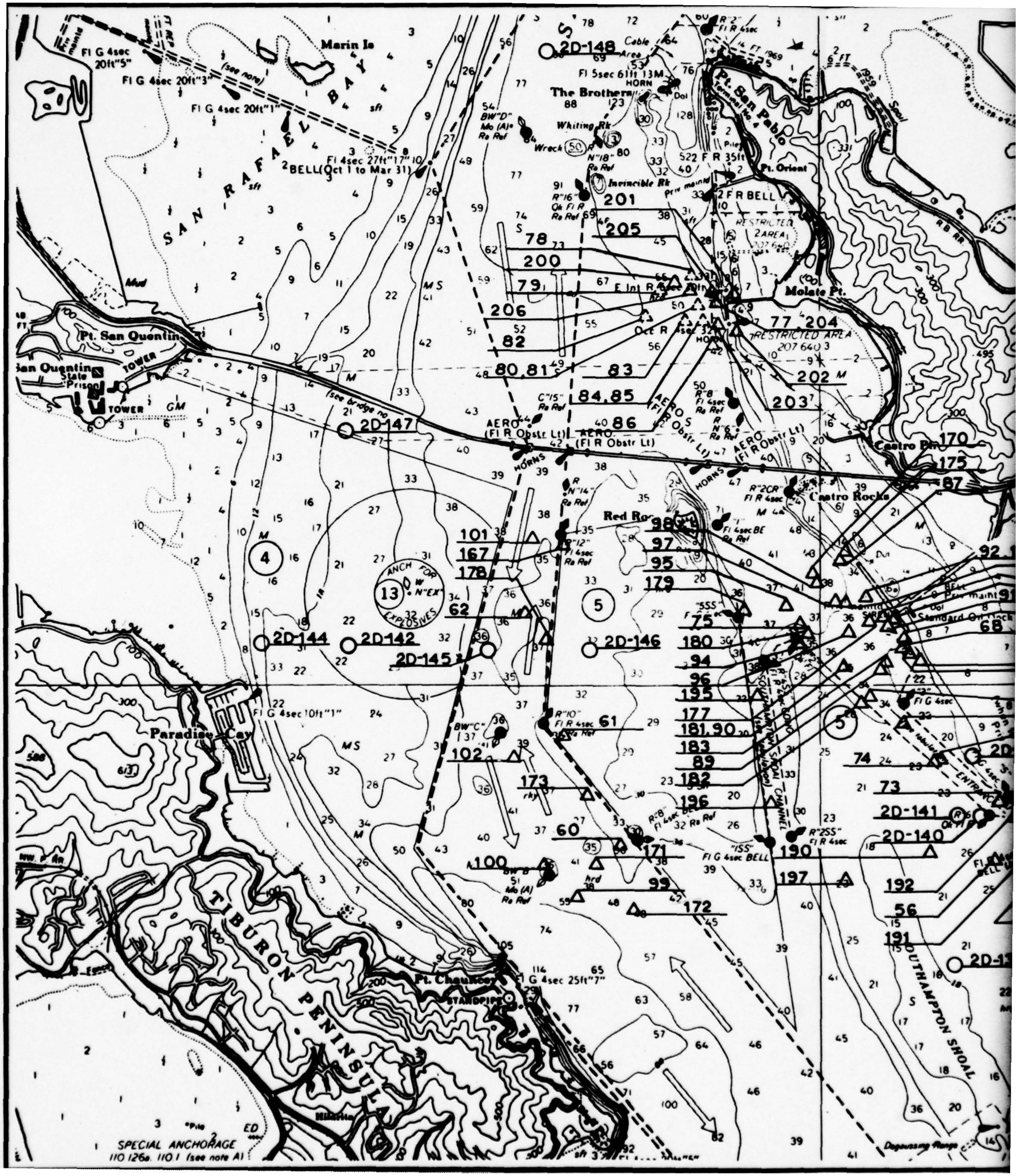
Fruitvale Avenue Bridge Reach	15.7	15.3	16.2	10.8		1-63	275	0.35
Fruitvale Avenue to San Leandro Bay	11.0	14.4	13.7	7.3		1-63	275	0.73

a. Project depth is 25 feet but channel is dredged and maintained to 18 feet.
b. Except for shoaling to 23.4 feet in the vicinity of Lighted Buoy 3.
c. Depth was located near the channel edge about 200 yards northerly of Buoy 7; 33.9 feet was av in the remainder of the quarter.
d. Except for shoaling to 25.7 feet near the channel edge in approximately 47°48'30"N., 122°19'25'
e. The quarter has shoaled opposite Light 2; 32.4 feet was available in the remainder of the q
f. The controlling depth was located opposite Light 2.
g. The controlling depth was located in approx. 37°47'46"N., 122°19'00"W.
h. The channel has shoaled along the edge; a depth of 26.6 feet was available in the inside half quarter.
i Project depth was available in the quarter to the end of the 9th St. Wharf (37°47'13"N., 122°15' in 1970.

NOTE.-1. With local knowledge greater depths can be obtained in the outside quarters in other th shoalest portions noted above.
2. The Corps of Engineers should be consulted for changing conditions subsequent to the



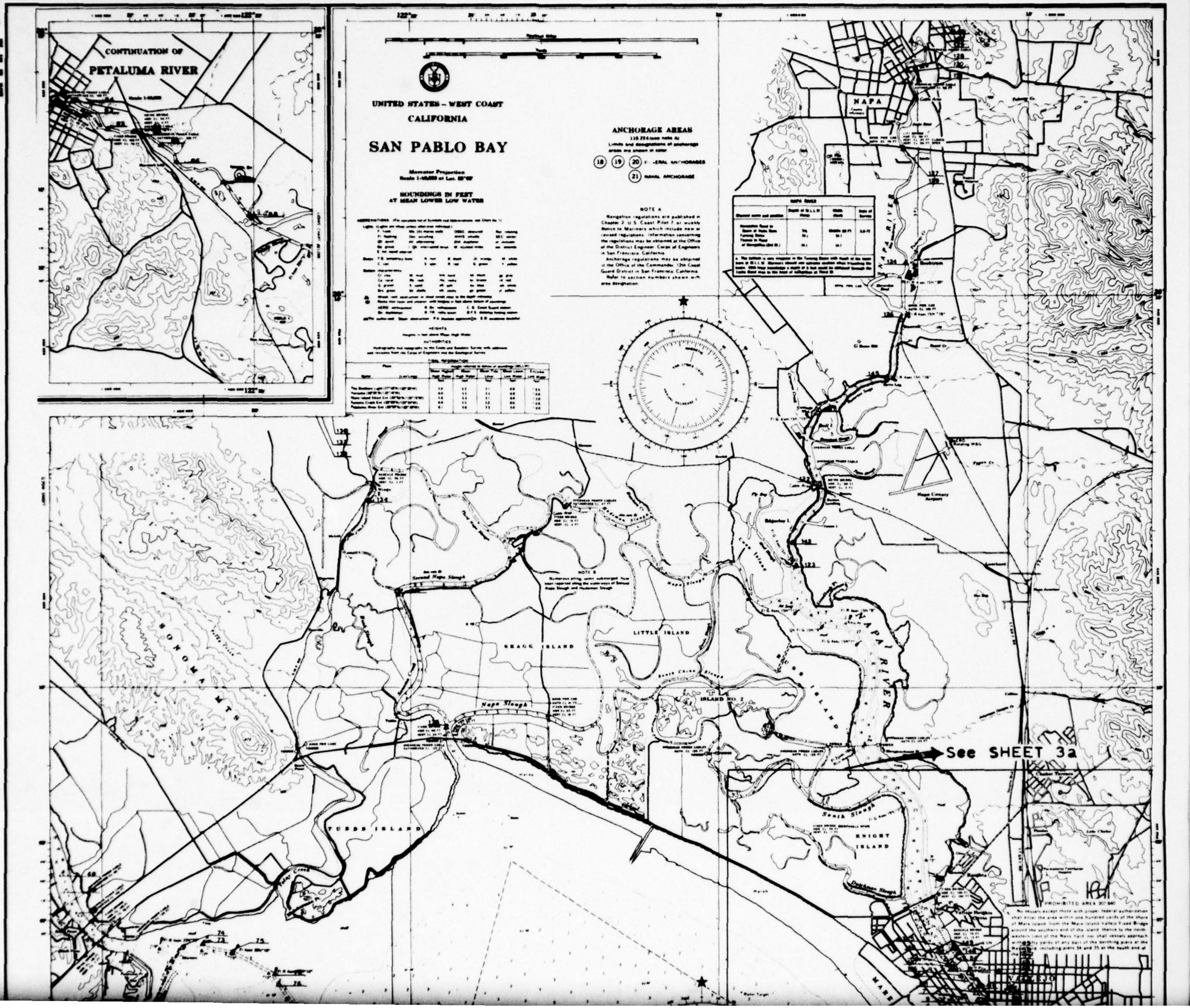
IN SHEET SHEET NO.
U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E
DRAWN: FILE NO.
TRACED: TO ACCOMPANY REPORT
CHECKED: DATED



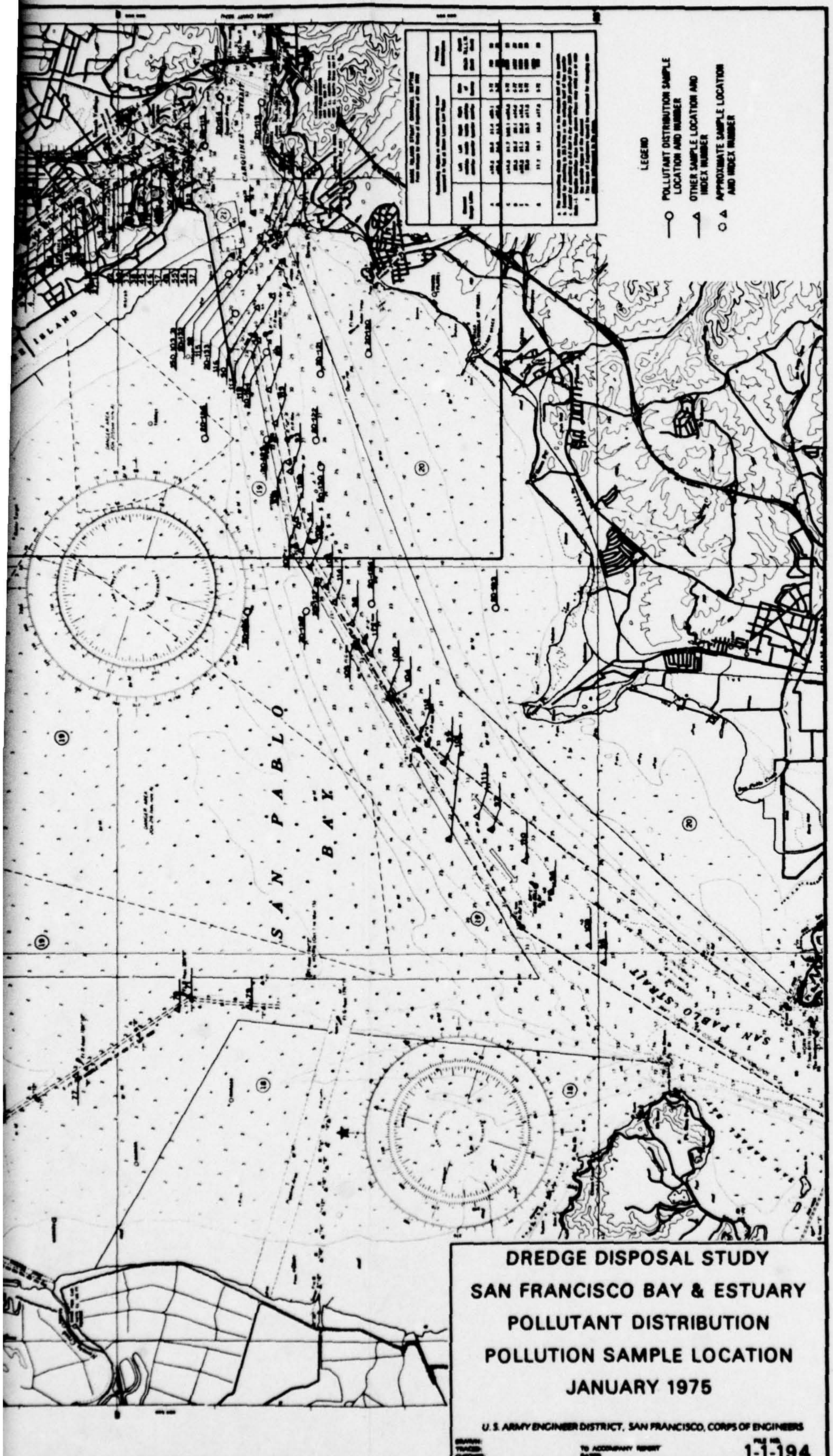
Marin Is
SAN RAFAEL BAY
The Brothers
Whiting Rk
Incinvible Rk
Pt. San Pablo
Pt. Orient
Molate Pt.
RESTRICTED AREA
Pt. San Quentin
San Quentin State Prison
TOWER
Castro Pt.
Castro Rocks
Red Rock
Standard Oil Dock
ANCH FOR EXPLOSIVES
Paradise Cay
TIBURON PENINSULA
Pt. Chauncey
STANDPIPE
SOUTHAMPTON SHOAL
SOUTHAMPTON SHOAL CHANNEL
SPECIAL ANCHORAGE
110.126a, 110.1 (see note A)
BELL (Oct 1 to Mar 31)
Fl G 4sec 20ft"5"
Fl G 4sec 20ft"3"
Fl G 4sec 20ft"1"
Fl 4sec 27ft"17"
Fl 5sec 61ft 13M HORN
2D-148
2D-147
2D-144
2D-142
2D-145
2D-146
2D-141
2D-140
AERO (Fl R Obstr Lt)
HORNS
Fl G 4sec 10ft"1"
Fl G 4sec 25ft"7"
Degaussing Range


SAN PABLO
North Richmond
RICHMOND
Marsh
Being filled
Ditch
Wildcat Creek
Castro Creek
OVHD PWR CAB
TANK
MacDonald Ave.
A.T. & S.F. RR.
Cutting Blvd.
Hoffman Blvd.
State Hy No 17
San Pablo Avenue
Richmond Yacht Hbr
SANTE FE CHANNEL
HARBOR CHANNEL
Inner Harbor Basin
Terminal No. 3
STACK
GAS TANK
Pt. Potrero
POINT POTRERO REACH
Richmond Inner Harbor
Brooks I
Subm stake
Foul
E Int 6sec 35ft
Fl R 4sec 15ft
MAGNETIC
VAR 16°45'E (1973)
176
169
63 64
65,66,67
68
88
184
185
53
54
55
58
59
70
186
57
71
188
187
189
69
SHEET SHEET NO.
U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E
DRAWN: FILE NO.
TRACED: TO ACCOMPANY REPORT
CHECKED: DATED

SHEET 2b

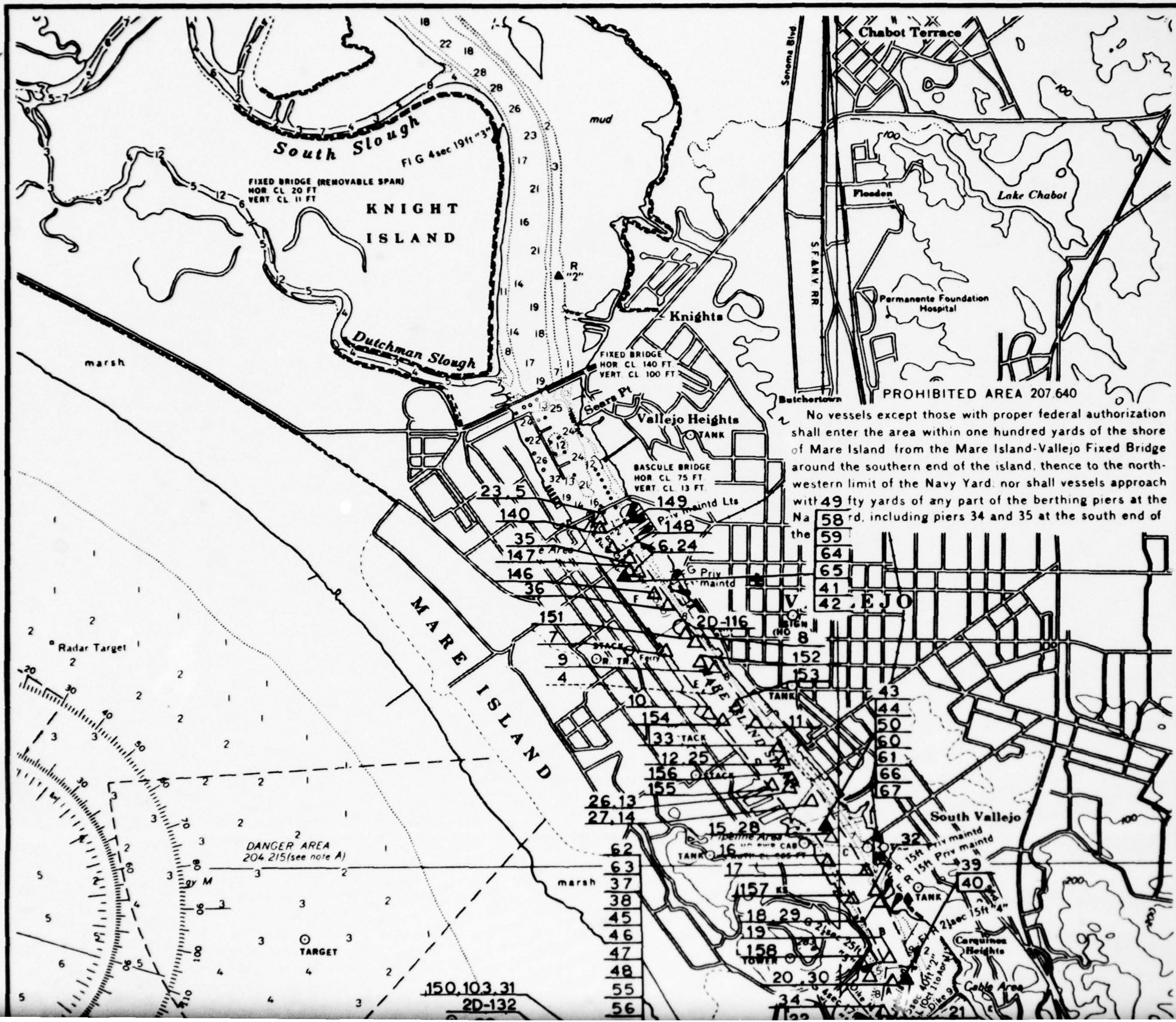


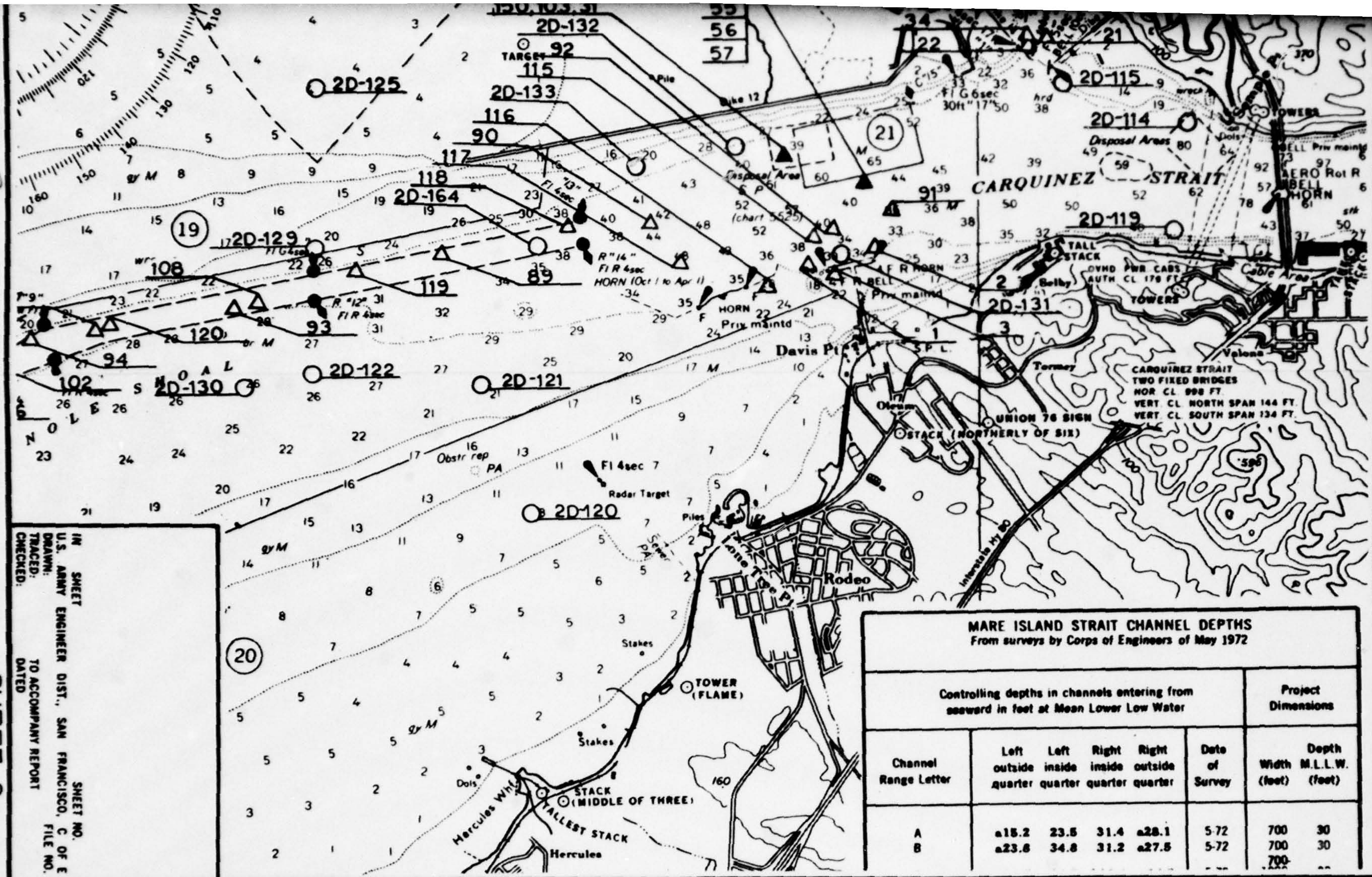
CONTINUATION OF
PETALUMA RIVER
UNITED STATES – WEST COAST
CALIFORNIA
SAN PABLO BAY
Mercator Projection
SOUNDINGS IN FEET
AT MEAN LOWER LOW WATER
ANCHORAGE AREAS
NOTE A
NOTE B
NAPA
NAPA RIVER
Napa County Airport
Second Napa Slough
SKAGG ISLAND
LITTLE ISLAND
ISLAND NO. 2
Napa Slough
SONOMA MTS
TUBBS ISLAND
KNIGHT ISLAND
South Slough
See SHEET 3a
PROHIBITED AREA


LEGEND
POLLUTANT DISTRIBUTION SAMPLE LOCATION AND NUMBER
OTHER SAMPLE LOCATION AND INDEX NUMBER
APPROXIMATE SAMPLE LOCATION AND INDEX NUMBER
CARQUINEZ STRAIT
SAN PABLO BAY
SAN PABLO STRAIT
ISLAND
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY & ESTUARY
POLLUTANT DISTRIBUTION
POLLUTION SAMPLE LOCATION
JANUARY 1975
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS
TO ACCOMPANY REPORT
1-1-194

2

SHEET 3


PROHIBITED AREA 207.640
No vessels except those with proper federal authorization shall enter the area within one hundred yards of the shore of Mare Island from the Mare Island-Vallejo Fixed Bridge around the southern end of the island, thence to the north-western limit of the Navy Yard, nor shall vessels approach within fifty yards of any part of the berthing piers at the Navy Yard, including piers 34 and 35 at the south end of the
Chabot Terrace
Lake Chabot
Permanente Foundation Hospital
Flosden
S.F.&N.V. RR
Sonoma Blvd
Butchertown
Knights
South Slough
Fl G 4sec 19ft "3"
FIXED BRIDGE (REMOVABLE SPAN)
HOR CL 20 FT
VERT CL 11 FT
KNIGHT ISLAND
Dutchman Slough
mud
marsh
FIXED BRIDGE
HOR CL 140 FT
VERT CL 100 FT
Sears Pt
Vallejo Heights
TANK
BASCULE BRIDGE
HOR CL 75 FT
VERT CL 13 FT
MARE ISLAND
MARE ISLAND STRAIT
South Vallejo
Carquinez Heights
Cable Area
Radar Target
DANGER AREA
204.215 (see note A)
TARGET



MARE ISLAND STRAIT CHANNEL DEPTHS
From surveys by Corps of Engineers of May 1972

Channel Range Letter	Controlling depths in channels entering from seaward in feet at Mean Lower Low Water: Left outside quarter	Left inside quarter	Right inside quarter	Right outside quarter	Date of Survey	Project Dimensions: Width (feet)	Depth M.L.L.W. (feet)
A	a15.2	23.5	31.4	a28.1	5-72	700	30
B	a23.8	34.8	31.2	a27.5	5-72	700	30

IN SHEET SHEET NO.
U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E
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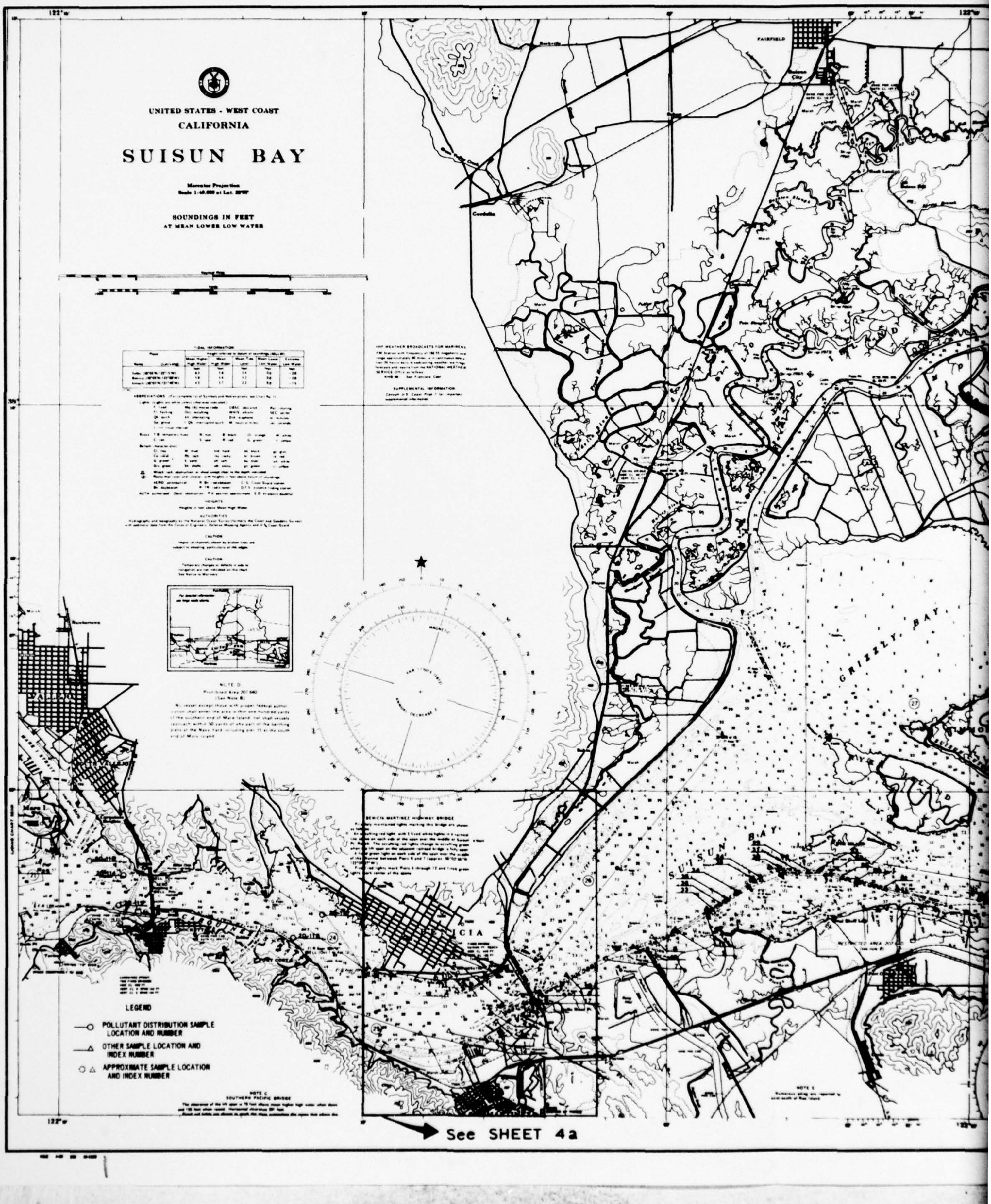
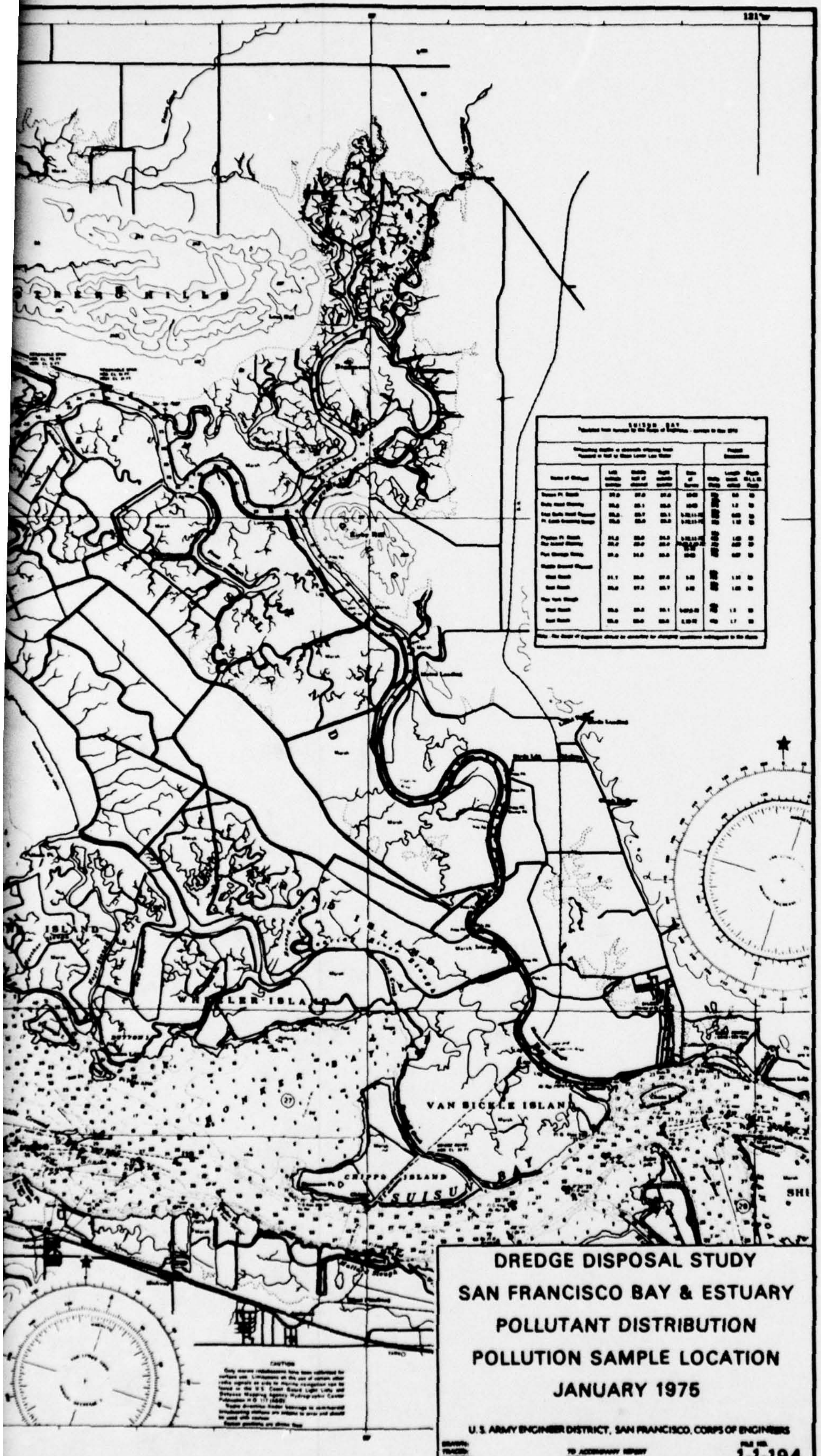
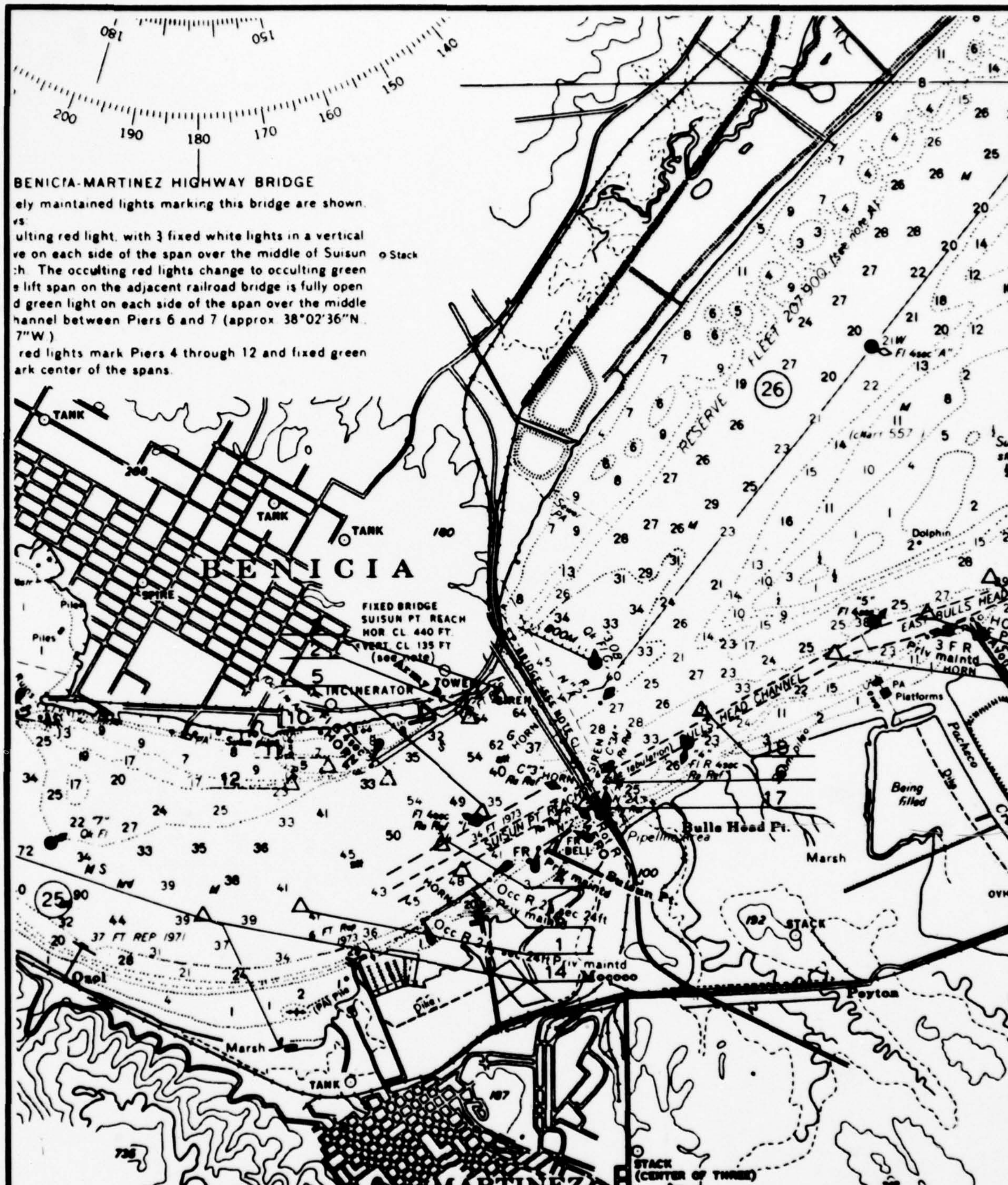
SHEET 3a


UNITED STATES - WEST COAST
CALIFORNIA
SUISUN BAY
SOUNDINGS IN FEET
AT MEAN LOWER LOW WATER
GRIZZLY BAY
SUISUN BAY
LEGEND
POLLUTANT DISTRIBUTION SAMPLE LOCATION AND NUMBER
OTHER SAMPLE LOCATION AND INDEX NUMBER
APPROXIMATE SAMPLE LOCATION AND INDEX NUMBER
See SHEET 4a


VAN SICKLE ISLAND
CHIPPS ISLAND
SUISUN BAY
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY & ESTUARY
POLLUTANT DISTRIBUTION
POLLUTION SAMPLE LOCATION
JANUARY 1975
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS
1-1-194

2

SHEET 4



IN SHEET	SHEET NO.
U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E	
DRAWN:	FILE NO.
TRACED:	TO ACCOMPANY REPORT
CHECKED:	DATED

SHEET 4a

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS
OF LABORATORY: SOUTH PACIFIC DIVISION
P.O. Box 37, Sausalito, CA 94965
UNIT OF MEASUREMENT: Parts per million of dry weight

PROJECT TITLE: MARE ISLAND STRAIT CHANNEL
DATE OF SAMPLE: 6 - 7 Feb 75
TYPE OF TEST (Bulk Sediment Analysis or Standard Elutriate): Bulk Sediment

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
2D-126(A)	-22.0'to -25.0'	1.1*	1.0	40	95	1,070
2D-126(A)	-25.0'to -27.2'	1.0	1.0	37	89	881
2D-127(B)	-26.0'to -29.0'	0.9	0.8	36	93	937
2D-127(B)	-29.0'to -30.9'	1.2*	0.9	42	97	828
2D-128(C)	-26.0'to -28.5'	0.6	1.1	41	106	904
2D-128(C)	-28.5'to -30.4'	0.7	1.0	45	97	910
2D-129(D)	-28.0'to -31.0'	0.5	1.1	41	104	991
2D-130(E)	-21.0'to -23.5'	0.5	0.8	34	87	692
2D-130(E)	-23.5'to -25.0'	0.7	1.0	44	99	922
2D-130(E)	-26.0'to -27.5'	0.9	1.1	42	96	876
2D-130(E)	-28.5'to -31.0'	0.6	1.2	42	91	800
2D-131(F)	-28.0'to -31.0'	0.5	1.0	36	96	630
2D-132(H)	-29.0'to -32.0'	0.6	1.2	42	105	862
2D-133(G)	-29.0'to -32.0'	0.5	0.9	35	96	687
2D-134(I)	-29.0'to -32.0'	0.6	1.2	36	100	732
2D-135(J)	-28.0'to -31.0'	0.5	1.1	38	106	650
2D-136(K)	-28.0'to -31.0'	0.5	1.3	43	106	487
2D-137(L)	-27.0'to -30.0'	0.5	0.9	31	91	370
2D-137(L)	-30.0'to -31.5'	0.8	1.1	43	97	722
E. P. A. Max. Limits for Fresh Water Disposal		1.0	2.0	120	210	1,500

*SAMPLES ON THIS PAGE WHICH EXCEED THE PROPOSED EPA REGION IX INTERIM DREDGE SPOIL DISPOSAL CRITERIA
(Laboratory Nos. PC-2109 through PC-2128)

Inclosure No. 4-5

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS
OF LABORATORY: South Pacific Division
P.O. Box 37, Sausalito, CA 94965
UNIT OF MEASUREMENT: mg/l

PROJECT TITLE: MARE ISLAND STRAIT CHANNEL
DATE OF SAMPLE: 6-7 Feb 75
TYPE OF TEST (Bulk Sediment Analysis or Standard Elutriate): Standard Elutriate

SAMPLE NO.	SAMPLE DEPTH	COPPER	CADMIUM	LEAD	ZINC	OIL & GREASE
Disposal	Site Water	0.03	0.003	0.02	0.10	11.2
2D-126(A)	-22' to -25'	0.03	0.007	0.03	0.19	-
"	-25' to -27.2'	0.02	0.008	0.02	0.06	-
2D-127(B)	-26' to -29.0'	0.02	0.012	0.02	0.03	22.2
"	-29.0'to -30.9'	0.11	0.015	0.11	0.03	22.2
2D-128(C)	-26' to -28.5'	0.03	0.016	0.03	0.04	-
"	-28.5'to -30.4'	0.01	0.007	0.01	0.09	-
2D-129(D)	-28' to -31'	0.01	0.008	0.01	0.04	-
2D-130(E)	-21' to -23.5'	0.02	0.008	0.02	0.20	-
"	-23.5'to -25.0'	0.02	0.015	0.02	0.04	-
"	-26.0'to -27.5'	0.02	0.011	0.02	0.09	-
"	-28.5'to -31.0'	0.03	0.018	0.03	0.07	-
2D-131(F)	-28' to -31.0'	0.03	0.013	0.03	0.14	24.2
2D-132(H)	-29' to -32.0'	0.04	0.013	0.04	0.27	12.6
2D-133(G)	-29' to -32.0'	0.03	0.028	0.03	0.06	34.8
2D-134(I)	-29' to -32.0'	0.03	0.028	0.03	0.07	25.8
2D-135(J)	-28' to -31'	0.03	0.017	0.03	0.06	20.8
2D-136(K)	-28' to -31.0'	0.03	0.033	0.03	0.08	11.7
2D-137(L)	-27' to -30.0'	0.02	0.025	0.02	0.15	-
"	-30.0'to -31.5'	0.02	0.024	0.02	0.05	-

~~*Exceeds Proposed guidelines developed pursuant to Section 404(b) of the~~ Federal Water Pollution Control Act published in Federal Register on 6 May 75.
NO SAMPLES ON THIS PAGE EXCEED THE PROPOSED GUIDELINES.

(Laboratory Nos. PC-2109 through PC-2128)

Inclosure No. 4-4

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS
OF LABORATORY: SOUTH PACIFIC DIVISION
P. O. Box 37, Sausalito, CA 94965
UNIT OF MEASUREMENT: Parts per million of dry weight

PROJECT TITLE: PINOLE SHOAL CHANNEL
DATE OF SAMPLE: 26 & 27 Feb 75
TYPE OF TEST (Bulk Sediment Analysis or Standard Elutriate): Bulk Sediment Analysis

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
2D-164	-34.5'to -37.0'	0.3	0.4	10	80	183
2D-165	-34.0'to -37.0'	0.2	0.5	14	81	483
2D-166	-34.0'to -37.0'	0.2	0.5	18	77	229
2D-167	-34.0'to -37.0'	0.2	0.7	25	104	364
2D-168	-34.0'to -37.0'	0.2	0.8	35	117	647
E. P. A. Max. Limits for Fresh Water		1.0	2.0	120	210	2700

Laboratory Nos. PC-2144 through PC-2148

Inclosure No. 5-5

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS
OF LABORATORY: DOD COE SFD Laboratory
P. O. Box 37, Sausalito, CA 94965
UNIT OF MEASUREMENT: Milligrams/liter

PROJECT TITLE: PINOLE SHOAL CHANNEL
DATE OF SAMPLE: 26 & 27 Feb 75
TYPE OF TEST (Bulk Sediment Analysis or Standard Elutriate): Standard Elutriate

SAMPLE NO.	SAMPLE DEPTH	COPPER	CADMIUM	LEAD	ZINC
PC-2169	Disposal water	0.10	0.02	0.06	0.25
2D-164	-34.5'to -37.0'	0.03	0.01	C.01	C.07
2D-165	-34.0'to -37.0'	0.04	0.01	0.02	0.05
2D-166	-34.0'to -37.0'	0.03	0.01	0.01	0.06
2D-167	-34.0'to -37.0'	0.04	0.01	0.05	0.08
2D-168	-34.0'to -37.0'	0.03	0.01	0.06	0.05

Laboratory Nos. PC-2144 through PC-2149

Inclosure No. 5-4

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS
OF LABORATORY: SOUTH PACIFIC DIVISION
P.O. Box 37, Sausalito, CA 94965
UNIT OF MEASUREMENT: Parts per million of dry weight

PROJECT TITLE: RICHMOND HARBOR
DATE OF SAMPLE: 24 & 25 Feb 1975
TYPE OF TEST (Bulk Sediment Analysis or Standard Elutriate): Bulk Sediment Analysis

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
2D-125	-32.0'to -34.7'	0.4	0.8	55	1.1	610
2D-125	-35.0'to -37.5'	0.4	1.2	57	155	1,138
2D-126	-34.0'to -37.0'	0.6	1.1	62	162	848
2D-127	-34.0'to -37.0'	0.3	0.9	50	162	707
2D-128	-34.0'to -37.0'	0.3	1.0	50	143	817
2D-129	-34.0'to -37.0'	0.2	1.2	48	159	1,194
2D-130	-34.0'to -37.0'	0.4	1.0	49	152	1,180
2D-131	-34.0'to -37.0'	0.3	0.8	29	114	714
2D-132	-34.0'to -36.8'	0.4	0.8	34	116	609
2D-133	-35.0'to -37.5'	0.3	0.8	36	122	622
2D-134	-36.0'to -38.5'	0.4	0.9	33	118	659
2D-134	-38.5'to -41.0'	0.3	0.7	11	74	159
2D-134	-41.0'to -43.5'	0.1	0.8	16	92	237
2D-134	-43.5'to -46.0'	0.1	0.7	15	91	106
2D-135	-39.0'to -41.5'	0.2	0.8	34	94	654
2D-135	-41.5'to -44.0'	0.1	0.6	14	72	155
2D-135	-44.0'to -46.5'	0.1	0.6	11	69	132
2D-136	-43.0'to -45.5'	0.3	0.7	26	96	710
2D-136	-45.5'to -48.0'	0.3	0.6	16	83	436
E. P. A. Max. Limits for Marine (Shallow) and Estuarine water		1.5	3.0	180	300	4,000

Laboratory Nos. PC-2150 through PC-2168

Inclosure No. 6-5

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS
OF LABORATORY: Corps of Engineers
South Pacific Division Laboratory
UNIT OF MEASUREMENT: Milligrams/liter
P. O. Box 37, Sausalito, CA 94965

PROJECT TITLE: RICHMOND HARBOR
DATE OF SAMPLE: 24 & 25 Feb 1975
TYPE OF TEST (Bulk Sediment Analysis or Standard Elutriate): Standard Elutriate

SAMPLE NO.	SAMPLE DEPTH	COPPER	CADMIUM	LEAD	ZINC	OIL & GREASE
PC-2169	Disposal water	0.10	0.02	0.06	0.25	17.2
2D-125	-32.0'to -34.7'	0.05	0.02	0.06	0.04	-
2D-125	-35.0'to -37.5'	0.05	0.02	0.06	0.08	-
2D-126	-34.0'to -37.0'	0.04	0.02	0.09	0.15	15.2
2D-127	-34.0'to -37.0'	0.06	0.02	0.06	0.02	21.6
2D-128	-34.0'to -37.0'	0.02	0.02	0.04	0.15	-
2D-129	-34.0'to -37.0'	0.03	0.02	0.05	0.07	11.5
2D-130	-34.0'to -37.0'	0.02	0.02	0.08	0.10	-
2D-131	-34.0'to -37.0'	0.07	0.02	0.09	0.06	21.6
2D-132	-34.0'to -36.8'	0.06	0.02	0.09	0.06	-
2D-133	-35.0'to -37.5'	0.06	0.02	0.08	0.05	21.0
2D-134	-36.0'to -38.5'	0.07	0.03	0.09	0.12	-
2D-134	-38.5'to -41.0'	0.06	0.02	0.09	0.02	-
2D-134	-41.0'to -43.5'	0.05	0.02	0.09	0.04	-
2D-134	-43.5'to -46.0'	0.05	0.02	0.10	0.04	-
2D-135	-39.0'to -41.5'	0.05	0.02	0.06	0.07	23.0
2D-135	-41.5'to -44.0'	0.05	0.02	0.08	0.04	26.0
2D-135	-44.0'to -46.5'	0.05	0.02	0.09	0.06	18.4
2D-136	-43.0'to -45.5'	0.07	0.02	0.09	0.10	-
2D-136	-45.5'to -48.0'	0.07	0.02	0.09	0.06	-

Laboratory Nos. PC-2150 through PC-2169

*Exceeds Proposed guidelines developed pursuant to Section 404(b) of the Federal Water Pollution Control Act published in Federal Register on 6 May 75.
NO SAMPLES ON THIS PAGE EXCEED THE PROPOSED GUIDELINES.

Inclosure No. 6-4

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS
OF LABORATORY: SOUTH PACIFIC DIVISION
P.O. Box 37, Sausalito, CA 94965
UNIT OF MEASUREMENT: parts per million of dry weight

PROJECT TITLE: OAKLAND OUTER HARBOR
DATE OF SAMPLE: 8 and 9 May 1975
TYPE OF TEST (Bulk Sediment Analysis or Standard Elutriate): Bulk Sediment Analysis

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
2D-149(A)	35.5 - 38.0	0.5	0.2	6	62	492
2D-150(B)	32.0 - 33.4	0.8	1.1	30	146	941
"	34.5 - 36.5	0.8	0.2	21	118	1,617
2D-151(C)	37.5 - 40.0	0.8	0.1-	24	125	590
2D-152(D)	40.0 - 41.0	0.4	0.1-	6	47	274
2D-153(E)	32.0 - 34.5	1.0	0.1-	22	141	990
"	34.5 - 37.0	0.8	0.2	32	139	907
2D-154(F)	38.0 - 40.0	0.7	0.1-	21	120	819
2D-155(G)	32.0 - 34.2	0.6	0.3	24	116	1,640
"	34.5 - 36.7	1.1	0.1-	19	110	1,032
2D-156(H)	37.0 - 39.2	0.6	0.3	21	131	1,415
E.P.A. Max. Limits for Marine (Shallow) and Estuarine Water		1.5	3.0	180	300	4,000

Inclosure No. 7-5

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS
OF LABORATORY: SOUTH PACIFIC DIVISION
P. O. Box 37, Sausalito, CA 94965
UNIT OF MEASUREMENT: mg/l

PROJECT TITLE: OAKLAND OUTER HARBOR
DATE OF SAMPLE: 8 and 9 May 1975
TYPE OF TEST (Bulk Sediment Analysis or Standard Elutriate): Standard Elutriate

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
Disposal Site Water		0.0007	0.0009	0.025	0.075	5.4
2D-149(A)	35.5 - 38.0	0.0007	0.001-	0.01-	0.02	20.0
2D-150(B)	32.0 - 33.4	0.0001-	0.001-	0.01-	0.02	16.2
"	34.5 - 36.5	0.0001-	0.001-	0.01-	0.01	19.2
2D-151(C)	37.5 - 40.0	0.0005	0.001-	0.01-	0.01	18.2
2D-152(D)	40.0 - 41.0	0.0007	0.001-	0.01-	0.03	17.0
2D-153(E)	32.0 - 34.5	0.0001-	0.001-	0.01-	0.17	1.0
"	34.5 - 37.0	0.0001-	0.001-	0.01-	0.01	22.8
2D-154(F)	38.0 - 40.0	0.0001-	0.001-	0.01-	0.01	3.4
2D-155(G)	32.0 - 34.2	0.0001-	0.001-	0.01-	0.01	5.5
"	34.5 - 36.7	0.0001-	0.001-	0.01-	0.01	2.4
2D-156(H)	37.0 - 39.2	0.0001-	0.001-	0.01-	0.04	2.4

*Exceeds proposed guidelines developed pursuant to Section 404(b) of the Federal Water Pollution Control Act published in Federal Register on 6 May 1975.

NO SAMPLES ON THIS PAGE EXCEED THE PROPOSED GUIDELINES.

Inclosure No. 7-4

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS
OF LABORATORY: SOUTH PACIFIC DIVISION
P.O. Box 37, Sausalito, CA 94965
UNIT OF MEASUREMENT: Parts per million of dry weight

PROJECT TITLE: OAKLAND INNER HARBOR
DATE OF SAMPLE: 9 May 1975
TYPE OF TEST (Bulk Sediment Analysis or Standard Elutriate): Bulk Sediment Analysis

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
2D-183(I)	38.0 - 40.0	0.3	0.4	14	88	1,100
2D-184(J)	38.5 - 40.7	0.6	0.5	34	134	2,016
2D-185(K)	37.0 - 39.3	0.2	0.1	2	59	100
2D-186(L)	36.0 - 38.2	0.3	0.4	9	89	484
2D-187(O)	38.0 - 39.5	0.8	0.7	21	170	1,701
2D-188(P)	36.5 - 38.5	0.5	0.3	10	70	1,230
2D-189(Q)	37.5 - 41.0	0.2	0.1	5	51	109
2D-190(R)	35.0 - 37.0	1.0	0.3	28	172	2,114
2D-191(M)	34.0 - 36.0	0.5	0.2	13	66	642
"	36.5 - 37.5	0.3	0.1-	3	24	110
2D-192(N)	39.5 - 42.0	0.3	0.1	6	82	871
E.P.A. Max. Limits for Marine(shallow) and Estuarine water		1.5	3.0	180	300	4,000

Inclosure No. 8-5

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS
OF LABORATORY: SOUTH PACIFIC DIVISION
P.O.Box 37, Sausalito, CA 94965
UNIT OF MEASUREMENT: mg/l

PROJECT TITLE: OAKLAND INNER HARBOR
DATE OF SAMPLE: 9 May 1975
TYPE OF TEST (Bulk Sediment Analysis or Standard Elutriate): Standard Elutriate

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
Disposal Site Water		0.0007	0.0009	0.025	0.075	5.4
2D-183(I)	38.0 - 40.0	0.0003	0.001-	0.01-	0.02	17.2
2D-184(J)	38.5 - 40.7	0.0001	0.001-	0.01-	0.03	19.2
2D-185(K)	37.0 - 39.3	0.0001	0.001-	0.01-	0.03	16.2
2D-186(L)	36.0 - 38.2	0.0001	0.001	0.08	0.02	19.6
2D-187(O)	38.0 - 39.5	0.0001	0.001-	0.01-	0.02	17.8
2D-188(P)	36.5 - 38.5	0.0001	0.001-	0.01-	0.01	21.2
2D-189(Q)	37.5 - 41.0	0.0001	0.001-	0.01-	0.02	4.0
2D-190(R)	35.0 - 37.0	0.0001	0.001-	0.01-	0.03	21.6
2D-191(M)	34.0 - 36.0	0.0001	0.001-	0.01-	0.01	18.8
"	36.5 - 37.5	0.0002	0.001-	0.01-	0.03	20.0
2D-192(N)	39.5 - 42.0	0.0002	0.001-	0.01-	0.01-	2.8

*Exceeds proposed guidelines developed pursuant to Section 404(b) of the Federal Water Pollution Control Act published in Federal Register on 6 May 1975.

NO SAMPLES ON THIS PAGE EXCEEDED THE PROPOSED GUIDELINES.

Inclosure No. 8-4

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS
OF LABORATORY: SPD Laboratory
P.O. Box 37, Sausalito, CA 94965
UNIT OF MEASUREMENT: Parts per million of Dry Weight

PROJECT TITLE: Mare Island Strait Channel
DATE OF SAMPLE: 6-9 July 1976
TYPE OF TEST (Bulk Sediment Analysis or Standard Elutriate): Bulk Sediment

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
2D-138 (A)	0.0 - 2.5	0.3	0.7	43	162	1320
"	2.5 - 5.0	0.2	0.7	49	201	700
"	5.0 - 7.5	0.2	0.6	36	159	690
2D-139 (B)	0.0 - 2.5	0.1-	0.6	41	164	1430
"	2.5 - 5.0	0.1-	0.7	48	176	750
"	5.0 - 7.5	0.1-	0.5	44	175	760
"	7.5 - 10.0	0.2	0.7	50	174	880
"	10.0 - 12.0	0.6	0.5	35	147	480
2D-140 (C)	0.0 - 2.5	0.1	0.3	53	167	490
"	2.5 - 5.0	0.3	0.8	47	187	230
"	5.0 - 7.5	0.1	0.4	37	179	740
2D-141 (D)	0.0 - 2.5	0.1	0.7	49	163	1120
"	2.5 - 5.0	0.2	0.7	49	180	790
"	5.0 - 7.5	0.2	0.6	48	177	760
"	7.5 - 10.0	0.2	0.4	48	177	820
"	10.0 - 12.5	0.2	0.6	45	166	800
2D-142 (E)	0.0 - 2.5	0.1	0.3	34	163	710
"	2.5 - 5.0	0.1	0.4	34	155	640
"	5.0 - 7.5	0.1	0.7	41	168	680
"	7.5 - 10.0	0.1	0.3	45	174	670
"	10.0 - 12.5	0.1	0.7	50	183	670
"	12.5 - 15.0	0.1	0.6	45	184	650
"	15.0 - 17.5	0.2	0.3	37	191	640
2D-143 (F)	0.0 - 2.5	0.1	0.8	29	159	610
"	2.5 - 5.0	0.2	0.5	41	169	680
"	5.0 - 7.5	0.1	0.3	32	146	660
"	7.5 - 10.0	0.1	0.4	32	140	660
"	10.0 - 12.5	0.1-	0.2	16	90	640
"	12.5 - 15.0	0.2	0.6	48	176	680
2D-144 (G)	0.0 - 2.5	0.1-	0.4	37	172	790
"	2.5 - 5.0	0.1-	0.4	29	146	780
"	5.0 - 7.5	0.1-	0.3	21	91	530
2D-145 (H)	0.0 - 2.0	0.1-	0.2	30	131	360
2D-146 (I)	0.0 - 2.5	0.1-	0.6	37	153	540
"	2.5 - 5.0	0.1-	0.6	46	192	741
"	5.0 - 7.5	0.1-	0.6	47	177	830
2D-147 (K)	0.0 - 2.5	0.1-	0.5	31	157	460
"	2.5 - 5.0	0.1-	0.6	48	168	740
2D-148 (L)	0.0 - 2.5	0.1	0.5	34	160	540
"	2.5 - 5.0	0.1-	0.4	31	167	691
"	5.0 - 7.5	0.1-	0.4	37	180	620

Inclosure No. 4-5

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS
OF LABORATORY: SPD Laboratory
P.O. Box 37, Sausalito, CA 94965
UNIT OF MEASUREMENT: mg/l

PROJECT TITLE: Mare Island Strait Channel
DATE OF SAMPLE: 6 - 9 July 1976
TYPE OF TEST (Bulk Sediment Analysis or Standard Elutriate): Standard Elutriate

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
2D-138 (A)	0.0 - 2.5	0.0002	0.002	0.001-	0.02	1
"	2.5 - 5.0	0.0002	0.002	0.001-	0.02	1
"	5.0 - 7.5	0.0002	0.002	0.001-	0.02	1
2D-139 (B)	0.0 - 2.5	0.0003	0.002	0.001-	0.02	1
"	2.5 - 5.0	0.0002	0.002	0.001-	0.02	1
"	5.0 - 7.5	0.0002	0.002	0.001-	0.02	1
"	7.5 - 10.0	0.0002	0.002	0.001-	0.02	1
"	10.0 - 12.0	0.0002	0.002	0.001-	0.02	1
2D-140 (C)	0.0 - 2.5	0.0002	0.002	0.001-	0.02	1
"	2.5 - 5.0	0.0002	0.002	0.001-	0.02	1
"	5.0 - 7.5	0.0002	0.002	0.001-	0.02	1
2D-141 (D)	0.0 - 2.5	0.0002	0.002	0.001-	0.02	1
"	2.5 - 5.0	0.0002	0.002	0.001	0.02	1
"	5.0 - 7.5	0.0002	0.002	0.001-	0.02	1
"	7.5 - 10.0	0.0002	0.002	0.001-	0.02	1
"	10.0 - 12.5	0.0002	0.002	0.001-	0.02	1
2D-142 (E)	0.0 - 2.5	0.0002	0.002	0.001-	0.03	1
"	2.5 - 5.0	0.0002	0.002	0.001-	0.02	1
"	5.0 - 7.5	0.0002	0.002	0.001-	0.02	1
"	7.5 - 10.0	0.0002	0.002	0.001-	0.02	1
"	10.0 - 12.5	0.0002	0.002	0.001-	0.02	1
"	12.5 - 15.0	0.0002	0.002	0.001-	0.02	1
"	15.0 - 17.5	0.0002	0.002	0.001-	0.02	1
2D-143(F)	0.0 - 2.5	0.0002	0.002	0.001-	0.02	1
"	2.5 - 5.0	0.0002	0.002	0.001-	0.03	1
"	5.0 - 7.5	0.0002	0.002	0.001-	0.02	1
"	7.5 - 10.0	0.0002	0.002	0.001-	0.02	1
"	10.0 - 12.5	0.0002	0.002	0.001-	0.02	1
"	12.5 - 15.0	0.0002	0.002	0.001-	0.02	1
2D-144 (G)	0.0 - 2.5	0.0002	0.002	0.001-	0.02	1
"	2.5 - 5.0	0.0002	0.002	0.001-	0.03	1
"	5.0 - 7.5	0.0002	0.002	0.001-	0.02	1
2D-145 (H)	0.0 - 2.0	0.0002	0.002	0.001-	0.02	1
2D-146 (I)	0.0 - 2.5	0.0002	0.002	0.001-	0.10	1
"	2.5 - 5.0	0.0002	0.002	0.001-	0.06	1
"	5.0 - 7.5	0.0002	0.002	0.001-	0.03	1
2D-147 (K)	0.0 - 2.5	0.0002	0.002	0.001-	0.03	1
"	2.5 - 5.0	0.0002	0.002	0.001-	0.02	1
2D-148 (L)	0.0 - 2.5	0.0002	0.002	0.001-	0.04	1
"	2.5 - 5.0	0.0002	0.002	0.001-	0.03	1
"	5.0 - 7.5	0.0002	0.002	0.001-	0.03	1
Dredge Site	Water	0.0003	0.003	0.001-	0.02	1
Disposal Site Water		0.0002	0.002	0.001	0.03	1

Inclosure No. 4-4

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS OF LABORATORY: SPD Laboratory
P.O.Box 37, Sausalito, CA 94965
UNIT OF MEASUREMENT: Parts per Million of Dry Weight

PROJECT TITLE: Richmond Harbor
DATE OF SAMPLE: 12 and 13 Aug. 1976
TYPE OF TEST Total Sediment Analysis or Standard Elutriate): Total Sediment

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
2D-137	0.0-2.5'	0.3	0.2	43	157	772
2D-138	0.0-2.5'	0.4	0.1	17	92	121
2D-139	0.0-2.5'	0.4	0.4	22	177	680
"	2.5-5.0'	0.2	0.5	32	158	665
2D-140	0.0-2.5'	0.3	0.4	35	136	205
2D-141	0.0-2.5'	0.3	0.7	37	151	950
2D-142	0.0-2.5'	0.2	0.6	19	134	778
2D-143	0.0-2.5'	0.1	0.1	38	133	794
2D-144	0.0-2.5'	0.1	0.2	37	110	570
2D-145	0.0-2.5'	0.1	0.5	36	108	547
2D-146	0.0-2.5'	0.3	0.5	49	119	544
"	2.5-4.7'	0.1	1.5	27	102	457
"	5.0'-7.2'	0.1	0.3	16	93	413
"	7.5'-8.8'	0.3	0.2	20	99	396
2D-147	0.0-1.7'	0.1	0.3	26	115	640
"	2.5'-5.0'	0.1	0.5	25	119	472
2D-148	0.0-2.5'	0.1	0.4	21	54	330

Inclosure No. 6-5

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS OF LABORATORY: SPD Laboratory
P.O.Box 37, Sausalito, CA 94965
UNIT OF MEASUREMENT: mg/l

PROJECT TITLE: Richmond Harbor
DATE OF SAMPLE: 12 and 13 Aug. 1976
TYPE OF TEST Total Sediment Analysis or Standard Elutriate): Standard Elutriate

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
2D-137	0.0-2.5'	0.003-	0.003	0.001-	0.01-	1-
2D-138	0.0-2.5'	0.003-	0.003	0.001-	0.01-	1-
2D-139	0.0-2.5'	0.003-	0.003	0.001-	0.01-	1-
"	2.5'-5.0'	0.003-	0.003	0.001-	0.01-	1
2D-140	0.0-2.5'	0.003-	0.003	0.001-	0.01-	1-
2D-141	0.0-2.5'	0.003-	0.003	0.001-	0.01-	1-
2D-142	0.0-2.5'	0.003-	0.003	0.001-	0.01-	1
2D-143	0.0-2.5'	0.003-	0.003	0.001-	0.01-	1
2D-144	0.0-2.5'	0.003-	0.003	0.001-	0.01-	1
2D-145	0.0-2.5'	0.003-	0.003	0.001-	0.01-	1
2D-146	0.0-2.5'	0.003-	0.003	0.001-	0.01-	1
"	2.5'-4.7'	0.003-	0.003	0.001-	0.01-	1
"	5.0'-7.2'	0.003-	0.003	0.001-	0.01-	1-
"	7.5'-8.8'	0.003-	0.003	0.001-	0.01-	1-
2D-147	0.0-1.7'	0.003-	0.003	0.001-	0.01-	1-
"	2.5'-5.0'	0.003-	0.003	0.001-	0.01-	1-
2D-148	0.0-2.5'	0.003-	0.003	0.001-	0.01-	1-
Dredge	Site water	0.003-	0.002	0.001-	0.01-	1-
Disposal	Site water	0.003-	0.003	0.001-	0.01-	1-

Inclosure No. 6-4

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS
OF LABORATORY: SPD Laboratory
P.O.Box 37, Sausalito, Ca. 94965
UNIT OF MEASUREMENT: Parts per Million of Dry Weight

PROJECT TITLE: Oakland Outer Harbor
DATE OF SAMPLE: 20 and 21 August 1976
TYPE OF TEST Total Sediment Analysis
or Standard Elutriate): Total Sediment

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
2D-157	0.0-2.5'	0.33	0.4	54	152	1510
2D-158	0.0-2.5'	0.3	0.2-	61	165	1470
2D-159	0.0-2.5'	0.06	0.2-	61	160	1260
2D-160	0.0-2.5'	0.2	0.2-	49	151	900
2D-161	0.0-2.5'	0.01	0.2-	30	88	670
2D-162	0.0-2.5'	0.02	0.2-	41	117	1110
"	2.5'-5.0'	0.01-	0.2-	24	45	710

Inclosure No. 7-5

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS
OF LABORATORY: SPD Laboratory
P.O.Box 37, Sausalito, CA. 94965
UNIT OF MEASUREMENT: mg/l

PROJECT TITLE: Oakland Outer Harbor
DATE OF SAMPLE: 20 and 21 August 1976
TYPE OF TEST Total Sediment Analysis
or Standard Elutriate): Standard Elutriate

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
2D-157	0.0-2.5'	0.006	0.002	0.006	0.04	1-
2D-158	0.0-2.5'	0.006	0.002	0.006	0.04	1-
2D-159	0.0-2.5'	0.005	0.002	0.006	0.04	1-
2D-160	0.0-2.5'	0.007	0.002	0.006	0.04	1-
2D-161	0. 0-2.5'	0.006	0.002	0.006	0.04	1-
2D-162	0.0-2.5'	0.006	0.002	0.006	0.04	1-
	2.5'-5.0'	0.006	0.002	0.006	0.04	1-
Dredge	Site Water	0.006	0.003	0.009	0.01-	1-
Disposal	Site Water	0.006	0.002	0.006	0.04	1-

Inclosure No. 7-4

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS OF LABORATORY: SPD Laboratory
P.O.Box 37, Sausalito, CA. 94965
UNIT OF MEASUREMENT: Parts per Million of Dry Weight

PROJECT TITLE: Oakland Inner Harbor
DATE OF SAMPLE: 21 and 23 August 1976
TYPE OF TEST Total Sediment Analysis or Standard Elutriate): Total Sediment

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
2D-193	0.0-2.5'	0.02	0.2-	24	79	720
2D-194	0.0-2.5'	0.06	0.2-	58	151	1600
2D-195	0.0-2.5'	0.05	0.6	56	144	1510
2D-196	0.0-2.5'	0.02	0.2-	22	120	730
2D-197	0.0-2.5'	0.07	0.4	61	171	1650
2D-198	0.0-2.5'	0.06	0.2-	36	104	760
2D-199	0.0-2.5'	0.04	0.8	60	163	1330
2D-200	0.0-2.5'	0.4	0.4	67	185	1460
2D-201	0.0-2.5'	0.05	0.3	37	122	760
2D-202	0.0-2.5'	0.06	0.4	36	127	760

Inclosure No. 8-5

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS OF LABORATORY: SPD Laboratory
P.O.Box 37, Sausalito, CA. 94965
UNIT OF MEASUREMENT: mg/1

PROJECT TITLE: Oakland Inner Harbor
DATE OF SAMPLE: 21 and 23 August 1976
TYPE OF TEST Total Sediment Analysis or Standard Elutriate): Standard Elutriate

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
2D-193	0.0-2.5'	0.006	0.002	0.006	0.04	1-
2D-194	0.0-2.5'	0.005	0.002	0.006	0.04	1-
2D-195	0.0-2.5'	0.006	0.002	0.006	0.04	1-
2D-196	0.0-2.5'	0.006	0.002	0.006	0.04	1-
2D-197	0.0-2.5'	0.006	0.002	0.006	0.04	1-
2D-198	0.0-2.5'	0.006	0.002	0.006	0.04	1-
2D-199	0.0-2.5'	0.006	0.002	0.006	0.04	1-
2D-200	0.0-2.5'	0.006	0.002	0.006	0.04	1-
2D-201	0.0-2.5'	0.006	0.002	0.006	0.04	1-
2D-202	0.0-2.5'	0.006	0.002	0.004	0.04	1-
Dredge	Site Water	0.006	0.003	0.009	0.01-	1-
Disposal	Site Water	0.006	0.002	0.006	0.04	1-

Inclosure No. 8-4

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS
OF LABORATORY: SPD Laboratory
P.O. Box 37, Sausalito, CA 94965
UNIT OF MEASUREMENT: Parts per Million of Dry Weight

PROJECT TITLE: Suisun Bay Channel
DATE OF SAMPLE: 18 July 1976
TYPE OF TEST (Bulk Sediment Analysis or Standard Elutriate): Bulk Sediment

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
2D-27 (C)	0.0 - 2.5	0.1-	0.3	11	67	200
"	2.5 - 5.0	0.1-	0.1	11	73	190
"	5.0 - 7.5	0.1-	0.2	3	67	190
2D-28 (B)	0.0 - 2.5	0.1-	0.2	1	39	120
"	2.5 - 5.0	0.1-	0.2	3	71	230
2D-29 (A)	0.0 - 2.5	0.1-	0.2	2	47	120
"	2.5 - 5.0	0.1-	0.1	2	49	170

Inclosure No. 5-3

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS
OF LABORATORY: SPD Laboratory
P.O. Box 37, Sausalito, CA 94965
UNIT OF MEASUREMENT: mg/l

PROJECT TITLE: Suisun Bay Channel
DATE OF SAMPLE: 18 July 1976
TYPE OF TEST (Bulk Sediment Analysis or Standard Elutriate): Standard Elutriate

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
2D-27 (C)	0.0 - 2.5	0.0002	0.001	0.001-	0.02	1
"	2.5 - 5.0	0.0002	0.001	0.001-	0.02	1
"	5.0 - 7.5	0.0002	0.001	0.001-	0.02	1
2D-28 (B)	0.0 - 2.5	0.0002	0.001	0.001-	0.02	1
"	2.5 - 5.0	0.0002	0.001	0.001-	0.02	1
2D-29 (A)	0.0 - 2.5	0.0002	0.001	0.001-	0.02	1
"	2.5 - 5.0	0.0002	0.001	0.001-	0.02	1
Dredge Site Water		0.0003	0.002	0.001-	0.02	1
Disposal Site Water		0.0002	0.001	0.001-	0.02	1

Inclosure No. 5-2

CORPS OF ENGINEERS [illegible] DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS
OF LABORATORY: South Pacific Division
P.O. Box 37, Sausalito, CA 94965
UNIT OF MEASUREMENT: Parts per million of dry weight

PROJECT TITLE: Alameda Naval Air Station
DATE OF SAMPLE: 16 & 17 October 1976
TYPE OF TEST Total Sediment Analysis
or Standard Elutriate): Total Sediment

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
2D-27	0.0' - 2.5'	0.1-	3.0	59	120	1930
2D-28	0.0' - 2.5'	0.1-	2.3	66	171	2350
2D-29	0.0' - 2.5'	0.1	1.0	33	100	1330
2D-30	0.0' - 5.0'	0.1	1.4	52	118	1280
2D-31	0.0' - 2.5'	0.1-	1.4	37	101	1200
2D-32	0.0' - 2.5'	0.1	1.5	39	106	1200
2D-33	0.0' - 2.5'	0.1	1.4	38	99	1170
2D-34	0.0' - 2.5'	0.1	0.8	26	77	880
2D-35	0.0' - 2.5'	0.1	0.7	22	64	600
2D-36	0.0' - 5.0'	0.1	1.0	27	27	1000
2D-37	0.0' - 2.5'	0.1-	0.2	16	16	97
2D-38	0.0' - 2.5'	0.1	1.3	35	94	1100
2D-39	0.0 - 2.5'	0.1	0.9	28	82	1080

Inclosure No. 9-5

CORPS OF [illegible]
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS
OF LABORATORY: South Pacific Division
P.O. Box 37, Sausalito, CA 94965
UNIT OF MEASUREMENT: mg/l

PROJECT TITLE: Alameda Naval Air Station
DATE OF SAMPLE: 16 & 17 October 1976
TYPE OF TEST (Total Sediment Analysis
or Standard Elutriate): Standard Elutriate

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
2D-27	0.0' - 2.5'	0.0001-	0.06	0.005-	0.07	0.4
2D-28	0.0' - 2.5'	0.0001-	0.06	0.005-	0.07	0.4
2D-29	0.0' - 2.5'	0.0001-	0.06	0.005-	[illegible]	0.4
2D-30	0.0' - 5.0'	0.0001-	0.06	0.005-	[illegible]	0.4
2D-31	0.0' - 2.5'	0.0001-	0.06	0.005-	0.07	0.4
2D-32	0.0' - 2.5'	0.0001-	0.06	0.005-	0.07	0.4
2D-33	0.0' - 2.5'	0.0001-	0.06	0.005-	0.07	0.5
2D-34	0.0' - 2.5'	0.0001-	0.06	0.005-	0.07	0.4
2D-35	0.0' - 2.5'	0.0001-	0.06	0.005-	0.07	0.4
2D-36	0.0' - 5.0'	0.0001-	0.06	0.005-	0.07	0.6
2D-37	0.0' - 2.5'	0.0001-	0.06	0.005-	[illegible]	0.4
2D-38	0.0' - 2.5'	0.0001-	0.06	0.005-	0.07	0.4
2D-39	0.0' - 2.5'	0.0001-	0.06	0.005-	0.07	0.4
Dredge Site Water		0.0001-	0.07	0.005-	0.06	0.8
Disposal Site Water		0.0001-	0.06	0.00[illegible]-	0.07	0.4

Inclosure No. 9-4

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS OF LABORATORY: SPD Laboratory
P.O. Box 37, Sausalito, CA 94965
UNIT OF MEASUREMENT: Parts per Million of Dry Weight

PROJECT TITLE: Petaluma, CA
DATE OF SAMPLE: 8 Dec 76
TYPE OF TEST (Total Sediment Analysis or Standard Elutriate): Total Sediment

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
2D-179	0.0' - 3.0'	0.4	0.1	26	67	590
	3.0' - 6.0'	0.4	0.1	30	70	570
2D-180	0.0' - 3.0'	0.3	0.1	28	74	630
	3.0' - 6.0'	0.6	0.1	28	76	520
2D-181	0.0' - 3.0'	0.4	0.3	26	112	604
	3.0' - 6.0'	0.4	0.1	29	74	670
2D-182	0.0' - 3.0'	0.3	0.2	28	78	760
	3.0' - 6.0'	0.3	0.1	30	72	410
2D-183	0.0' - 3.0'	0.6	0.1	23	60	550
	3.0' - 6.0'	0.3	0.1	24	64	730
2D-184	0.0' - 3.0'	0.4	0.1	26	67	700
	3.0' - 6.0'	0.4	0.1	26	67	570

Inclosure No. 14-5

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS OF LABORATORY: SPD Laboratory
P.O. Box 37, Sausalito, CA 94965
UNIT OF MEASUREMENT: mg/l

PROJECT TITLE: Petaluma, CA
DATE OF SAMPLE: 8 Dec 76
TYPE OF TEST Sediment Analysis or Standard Elutriate): Standard Elutriate

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
2D-179	0.0' - 3.0'	0.0007	0.01	0.01	0.04	0.5
	3.0' - 6.0'	0.0008	0.01	0.01	0.04	0.5
2D-180	0.0' - 3.0'	0.0007	0.01	0.01	0.04	0.4
	3.0' - 6.0'	0.0007	0.01	0.01	0.04	0.4
2D-181	0.0' - 3.0'	0.0007	0.01	0.01	0.04	0.4
	3.0' - 6.0'	0.0007	0.01	0.01	0.04	0.4
2D-182	0.0' - 3.0'	0.0008	0.01	0.01	0.04	0.5
	3.0' - 6.0'	0.0009	0.01	0.01	0.04	0.4
2D-183	0.0' - 3.0'	0.0007	0.01	0.01	0.04	0.4
	3.0' - 6.0'	0.0009	0.01	0.01	0.04	0.5
2D-184	0.0' - 3.0'	0.0008	0.01	0.01	0.04	0.4
	3.0' - 6.0'	0.0008	0.01	0.01	0.04	0.4
Dredge Site Water		0.0009	0.01	0.01	0.04	0.2
Disposal Site Water		0.0007	0.01	0.01	0.04	0.4

Inclosure No. 14-4

Rudd

2470 FIFTH STREET
BERKELEY, CALIF. 94710

(415) [illegible]

February 22, 1977

RECORD OF ANALYSIS

Port of Redwood City
775 Harbor Boulevard
Redwood City, California

Attention: Mr. Freeman

ANALYSES OF CORE SAMPLES RECEIVED 2/19/77

SAMPLE	LEAD mg/kg dry	ZINC mg/kg dry	CADMIUM mg/kg dry	MERCURY mg/kg dry	OIL & GREASE mg/kg dry
A1	51	160	1.5	.22	370
B1-1	44	150	1.8	.25	680
B2-1	42	150	1.8	.25	300
C1-1	55	160	1.6	.28	160
C2-1	49	160	1.7	.30	470
C3-1	42	150	1.3	.30	240
D1-1	48	160	1.6	.29	510
D2-1	46	160	1.2	.18	1100
E1-1	42	150	1.2	.24	1100
E2-1	51	150	1.3	.32	400
F1-1	47	160	1.3	.32	550
F2-1	47	160	1.4	.33	740
G1-1	56	160	1.4	.32	920
G2-1	49	160	1.4	.19	1200
H1-1	52	170	1.5	.44	1100
H2-1	48	180	1.4	.26	700
I1	55	180	1.2	.34	500

M. W. Rudd
M. W. Rudd

2/22/77
Date

Inclosure No. 13-4

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS
OF LABORATORY: SPD Laboratory
P.O. Box 37, Sausalito, CA 94965
UNIT OF MEASUREMENT: mg/l

PROJECT TITLE: San Rafael Creek
DATE OF SAMPLE: 17 January 1977
TYPE OF TEST (Bulk Sediment Analysis or Standard Elutriate): Standard Elutriate

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
2D-2	0.0' - 3.0'	0.0001	0.0005-	0.001-	0.005	0.4
	3.0' - 6.0'	0.0001	0.0005-	0.001-	0.005	0.4
2D-3	0.0' - 3.0'	0.0001	0.0005-	0.001-	0.006	0.5
	3.0' - 6.0'	0.0001	0.0005-	0.001-	0.005	0.5
2D-4	0.0' - 3.0'	0.0001	0.0005-	0.001-	0.005	0.4
	3.0 - 6.0'	0.0001	0.0005-	0.001-	0.005	0.4
2D-5	0.0' - 3.0'	0.0001	0.0005-	0.001-	0.005	0.4
	3.0' - 6.0'	0.0001	0.0005-	0.001-	0.005	0.5

CORPS OF ENGINEERS - SAN FRANCISCO DISTRICT
CHEMICAL TESTS OF SAMPLES

NAME & ADDRESS
OF LABORATORY: SPD Laboratory
P.O. Box 37, Sausalito, CA 94965
UNIT OF MEASUREMENT: Part per Million of Dry Weight

PROJECT TITLE: San Rafael Creek
DATE OF SAMPLE: 17 January 1977
TYPE OF TEST (Bulk Sediment Analysis or Standard Elutriate): Total Sediment

SAMPLE NO.	SAMPLE DEPTH	MERCURY	CADMIUM	LEAD	ZINC	OIL & GREASE
2D-2	0.0' - 3.0'	0.3	0.2	41	136	422
	3.0' - 6.0'	0.2	0.4	36	127	774
2D-3	0.0' - 3.0'	-.3	0.4	39	123	659
	3.0' - 6.0'	0.2	0.3	36	131	537
2D-4	0.0' - 3.0'	0.2	0.1	32	111	577
	3.0' - 6.0'	0.3	0.1	33	126	611
2D-5	0.0' - 3.0'	0.3	0.1	48	143	959
	3.0' - 6.0'	0.2	0.2	44	141	881

Inclosure 10-4 R

LFE Environmental Analysis Laboratories
2030 Wright Avenue
Richmond, California 94804
(415) 235 2633
CORPORATION (TWX) 910-382 8132

HARDING LAWSON ASSOC.
JUN 13 1977

ANALYSIS REPORT

Customer: Harding Lawson Assoc.
P.O. Box 3030
San Rafael, CA 94902

Attention: Lyle Lewis

Date: June 9, 1977
Samples Received: May 24, 1977
LFE Reference No. 18100-2394
Purchase Order No.

Dredging Site Elutriate Analysis

Sample Designation	LFE No.	Mercury µg/l	Lead mg/l	Cadmium mg/l	Zinc mg/l	Oil & Grease mg/l
#1,0-3'	255-24-1	<0.001	<0.012	<0.005	0.014	1.8
#1,3-4'	255-24-2	<0.001	<0.010	<0.004	0.016	15
#2,0-3'	255-24-3	<0.001	<0.012	<0.04	0.021	3
#3,0-3'*	255-24-4	<0.001	<0.012	<0.005	0.011	12
#3,3-5'*	255-24-5	<0.002	<0.020	<0.008	0.018	16
#4,0-3'*	255-24-6	<0.001	<0.012	<0.005	0.018	13
#4,3-6'*	255-24-7	<0.001	<0.010	<0.001	0.013	13
#5,0-3'	255-24-8	<0.001	<0.005	<0.002	0.004	2.5
#5,3-6'	255-24-9	<0.001	<0.05	<0.01	0.014	27
#6,0-3'	255-24-10	<0.001	<0.025	<0.005	0.017	14
#6,3-6'	255-24-11	<0.001	<0.012	<0.005	0.014	2.3
#7,0-3'	255-24-12	<0.001	<0.012	<0.005	0.008	3.5
#7,3-6'	255-24-13	<0.001	<0.052	<0.004	0.038	3.3
#8,0-3'	255-24-14	<0.001	<0.012	<0.005	0.011	1.5
#8,3-6'	255-24-15	<0.001	<0.020	<0.009	0.017	5.1
#9,0-3'*	255-24-16	<0.001	<0.005	<0.002	0.006	4.4
#9,3-6'*	255-24-17	<0.001	<0.012	<0.005	0.026	1.3
#10,0-3'*	255-24-18	<0.001	<0.012	<0.005	0.016	2.9
#10,3-6'*	255-24-19	<0.001	<0.010	<0.001	0.010	7.3

*Samples from area to be dredged.

Michael Concannon
Michael Concannon, Supervisor
Environmental Laboratory

INCLOSURE NO. 10-6R

Analysis are performed according to EPA or State of California recommended methods when applicable
LFE Environmental is a State of California Approved Laboratory for complete chemical, bacteriological, and bioassay analyses.

LFE Environmental Analysis Laboratories

Analysis Report Continued

Customer: Harding Lawson
Date: June 9, 1977

Total Sediment Analysis

Sample Designation	LFE No.	Mercury µg/l	Lead mg/l	Cadmium mg/l	Zinc mg/l	Oil & grease mg/l
1, 0-3'	255-25-1	0.54	25	<0.6	150	730
2, 0-3'	255-25-2	0.72	22	<0.6	170	950
4, 0-3'*	255-25-6	0.77	34	<0.6	160	1,200
4, 3-6'*	255-25-7	0.71	11	<0.6	88	470
5, 0-3'	255-25-8	0.52	14	<0.6	120	460
5, 3-6'	255-25-9	0.11	<3.2	<0.6	90	200
6, 0-3'	255-25-10	0.18	<2.8	<0.6	88	500
6, 3-6'	255-25-11	0.47	10	<0.6	110	550
7, 0-3'	255-25-12	1.5	58	<0.6	200	1,800
9, 0-3' *	255-25-16	0.13	31	<0.6	170	980
9, 3-6' *	255-25-17	0.61	31	<0.6	120	860

*Samples from area to be dredged.

Inclosure No. 10-7R

Project: Mare Island Strait Date 16 Aug 77
Type Bulk Sediment

Sample No.	Depth	Mercury	Cadmium	Lead	Zinc	Oil & Grease
2D-149	PT-1	0.7	0.5-	53	177	840
2D-159	PT-1	0.6	0.5-	54	133	590
	PT-2	0.5	0.5-	48	177	570
	PT-3	0.6	0.5-	47	170	530
2D-151	PT-1	0.6	0.5-	53	185	670
2D-152	PT-1	0.5	0.5-	51	191	660
	PT-2	0.5	0.5-	42	194	610
2D-153	PT-1	0.3	0.5-	37	164	620
	PT-2	0.4	0.5-	50	166	630
	PT-3	0.4	0.5-	44	170	710
	PT-4	0.7	0.5-	56	192	710
	PT-5	0.7	0.5-	52	186	750
2D-154	PT-1	0.1	0.5-	45	156	650
	PT-2	0.3	0.5-	39	170	460
2D-155	PT-1	0.3	0.5-	40	162	600
	PT-2	0.4	0.5-	52	182	590
2D-156	PT-1	0.3	0.5-	41	163	510
2D-157	Pt-1	0.5	0.5-	46	177	590
2D-158	PT-1	0.3	0.5-	41	162	510
	PT-2	0.3	0.5-	38	168	590

Project: Mare Island Strait Date 16 Aug 77
Type Elutriate

Sample No.	Depth	Mercury	Cadmium	Lead	Zinc	Oil & Grease
2D-149	PT-1	0.0004	0.003	0.006	0.011	28
2D-150	PT-1	0.0004	0.003	0.006	0.011	28
	PT-2	0.0004	0.003	0.006	0.011	27
	PT-3	0.0004	0.003	0.006	0.010	28
2D-151	PT-1	0.0004	0.003	0.006	0.011	29
2D-152	PT-1	0.0004	0.003	0.006	0.010	29
	PT-2	0.0004	0.003	0.006	0.010	28
2D-153	PT-1	0.0004	0.003	0.006	0.011	28
	PT-2	0.0004	0.003	0.006	0.010	29
	PT-3	0.0004	0.003	0.006	0.011	30
	PT-4	0.0004	0.003	0.006	0.011	29
	PT-5	0.0004	0.003	0.006	0.011	31
2D-154	PT-1	0.0004	0.003	0.006	0.010	29
	PT-2	0.0004	0.003	0.006	0.012	29
2D-155	PT-1	0.0004	0.003	0.006	0.011	28
	PT-2	0.0004	0.003	0.006	0.010	29
2D-156	PT-1	0.0004	0.003	0.006	0.011	28
2D-157	PT-1	0.0004	0.003	0.006	0.011	29
2D-158	PT-1	0.0004	0.003	0.006	0.011	29
	PT-2	0.0004	0.003	0.006	0.011	29
Dredge site water		0.0005	0.002	0.006	0.011	22
Disposal site water		0.0004	0.003	0.006	0.011	29

Project: Richmond Harbor Date 7 & 8 September 1977
Type Bulk Sediment

Sample No.	Depth	Mercury	Cadmium	Lead	Zinc	Oil & Grease
2D-149	0.0-2.5'	0.13	0.6-	64	179	930
2D-150	0.0-2.5'	0.10	0.6-	93	2C1	1040
2D-151	0.0-2.5'	0.07	0.6-	52	160	880
2D-151	2.5-5.0'	0.07	0.6-	53	168	880
2D-152	0.0-3.0'	0.15	0.6-	47	160	730
2D-153	0.0-3.0'	0.51	0.6-	50	168	1020
2D-154	0.0-2.5'	0.20	0.6-	47	140	790
2D-155	0.0-3.0'	0.14	0.6-	47	137	710
2D-156	0.0-3.0'	0.17	0.6-	51	129	560
2D-157	0.0-3.0'	0.14	0.6-	45	124	640
2D-158	0.0-3.0'	0.14	0.6-	38	128	590
2D-158	3.0-6.0'	0.12	0.6-	39	105	590
2D-159	0.0-3.0	0.02	0.6-	22	80	160
2D-160	0.0-3.0	0.02	0.6-	11	58	220

Project: Richmond Harbor Date 7 & 8 September 1977
Type Elutriate

Sample No.	Depth	Mercury	Cadmuim	Lead	Zinc	Oil & Grease
2D-149	0.0-2.5'	0.0003	0.003	0.005	0.024	1
2D-150	0.0-2.5'	0.0003	0.003	0.005	0.024	1
2D-151	0.022.5'	0.0003	0.003	0.005	0.024	1
2D-151	0.0-2.5'	0.0003	0.003	0.006	0.024	1
2D-152	0.0-3.0'	0.0003	0.003	0.005	0.024	1
2D-153	0.0-3.0'	0.0003	0.003	0.006	0.025	1
2D-154	0.0-2.5'	0.0003	0.003	0.005	0.024	1
2D-155	0.0-3.0'	0.0003	0.003	0.006	0.024	1
2D-156	0.0-3.0'	0.0003	0.003	0.006	0.024	1
2D-157	0.0-3.0'	0.0003	0.003	0.005	0.024	1
2D-158	0.0-3.0'	0.0003	0.003	0.005	0.024	1
2D-158	0.0-3.0'	0.0003	0.003	0.006	0.024	1
2D-159	0.0-3.0'	0.0003	0.003	0.006	0.024	1
2D-160	0.0-3.0'	0.0003	0.003	0.005	0.009	1
Dredge Site Water		0.0003	0.003	0.005	0.024	1
Disposal Site Water		0.0003	0.003	0.005	0.024	1

Project: Oakland Outer Harbor
Type Bulk

Date 5 &6 August 1977

Sample No.	Depth	Mercury	Cadmuim	Lead	Zinc	Oil & Grease
2D-163	3'	0.7	0.8	81	205	1690
2D-164	3'	0.4	0.5	68	197	1260
2D-165	3'	0.5-	0.5-	64	175	1270
2D-166	3'	0.2	0.5-	39	112	620
2D-167	3'	0.2	0.5-	54	163	1100
2D-168	3'	0.3	0.5-	54	156	1090

Project: Oakland Outer Harbor
Type Standard Elutriate

Date 5 & 6 August 1977

Sample No.	Depth	Mercury	Cadmuim	Lead	Zinc	Oil & Grease
2D-163	3'	0.0005	0.003	0.006	0.034	9
2D-164	3'	0.0005	0.003	0.006	0.034	8
2D-165	3'	0.0005	0.003	0.006	0.034	8
2D-166	3'	0.0005	0.003	0.006	0.036	8
2D-167	3'	0.0005	0.003	0.006	0.035	8
2D-168	3'	0.0006	0.003	0.006	0.034	9
		0.0006	0.003	0.009	0.030	6
		0.0005	0.003	0.006	0.037	7

Project: Oakland Inner Harbor Date 5 & 6 August 1977
Type Bulk

Sample No.	Depth	Mercury	Cadmuim	Lead	Zinc	Oil & Grease
2D-203	3'	0.1	0.5-	18	56	309
2D-204	3'	0.2	0.5-	63	177	1430
2D-205	3'	0.2	0.5-	39	132	780
2D-206	3'	0.1	0.5-	50	176	920
2D-207	3'	0.7	0.5-	72	228	1430
2D-208	3'	0.1	0.5-	19	52	350
2D-209	3'	0.1	0.5-	21	68	370
2D-210	3'	0.4	0.5-	87	217	1430
2D-211	3'	0.2	0.5-	17	40	270
2D-212	3'	0.6	0.5-	68	198	730

Project: Oakland Inner Harobr Date 5&6 August 1977
Type Standard Elutriate

Sample No.	Depth	Mercury	Cadmuiml	Lead	Zinc	Oil & Grease
2D-203	3'	0.0005	0.003	0.006	0.34	9
2D-204	3'	0.0005	0.003	0.006	0.034	6
2D-205	3'	0.0005	0.003	0.006	0.034	6
2D-206	3'	0.0005	0.003	0.006	0.036	6
2D-207	3'	0.0005	0.003	0.006	0.035	6
2D-208	3'	0.0005	0.003	0.006	0.034	6
2D-209	3'	0.0005	0.003	0.006	0.034	6
2D-210	3'	0.0005	0.003	0.006	0.034	6
2D-211	3'	0.0005	0.003	0.006	0.034	8
2D-212	3'	0.0005	0.003	0.006	0.035	10
Dredge Site Water		0.0004	0.003	0.006	0.028	9
Disposal Site Water		0.0005	0.003	0.006	0.037	7

Project: Mare Island Strait Channel Date 12 Sep 1978

Type Bulk Sediment

Sample NO.	Depth	Mercury	Cadmuim	Lead	Zinc	Oil & Grease
PT-165		0.3	0.5-	42	149	680
PT-166		0.3	0.5-	45	153	480
PT-167		0.3	0.5-	45	145	400
PT-168		0.3	0.5-	42	149	540
PT-169		0.2	0.5-	44	153	610
PT-170		0.4	0.5-	46	151	710
PT-171		0.2	0.5-	44	155	660
PT-172		0.3	0.5-	43	149	820
PT-173		0.3	0.5-	42	158	650
PT-174		0.4	0.5-	47	158	580
PT-175		0.3	0.5-	52	161	850

Project: Mare Island Strait Channel Date 12 Sep 1978

Type Standard Elutriate

Sample NO.	Depth	Mercury	Cadmuim	Lead	Zinc	Oil & Grease
PT-165		0.0009	0.0006	0.01-	0.021	1.0
PT-166		0.0009	0.0006	0.01-	0.021	1.0
Pt-167		0.0009	0.0006	0.01-	0.021	1.0
PT-168		0.0009	0.0006	0.01-	0.021	1.0
PT-169		0.0009	0.0006	0.01-	0.021	1.0
PT-170		0.0009	0.0006	0.01-	0.021	1.0
PT-171		0.0009	0.0006	0.01-	0.021	1.0
PT-172		0.0009	0.0006	0.01-	0.021	1.0
PT-173		0.0009	0.0006	0.01-	0.021	1.0
PT-174		0.0009	0.0006	0.01-	0.021	1.0
PT-175		0.0009	0.0006	0.01-	0.021	1.0
Dredge water		0.0008	0.0006	0.01-	0.008	1.6
Disposal site water		0.0009	0.0006	0.01-	0.021	1.0

Project: Mare Island Strait

Type Bulk Sediment

Date 1 July 1978

Sample No.	Depth	Mercury	Cadmuim	Lead	Zinc	Oil & Grease
2D-159	0-3'	0.2	0.6-	42	175	650
2D-160	0-3'	0.2	0.6-	44	172	568
2D-161	0-3'	0.2	0.6-	45	173	596
2D-162	0-3'	0.2	0.6-	41	174	594
2D-163	0-3'	0.2	0.6-	39	172	786
2D-164	0-3'	0.2	0.6-	49	183	665
				260	1049	3849

Project: Richmond Harbor — Date 9 & 10 August 1978

Type Bulk Sediment

Sample NO.	Depth	Mercury	Cadmuim	Lead	Zinc	Oil & Grease
2D-161		0.4	0.7-	56	159	080
2D-162		0.2	0.7-	59	144	740
2D-163		0.3	0.7-	53	159	900
2D-164		0.3	0.7	44	142	650
2D-165		0.3	0.8-	47	151	890
2D-166		0.2	0.7-	38	151	720
2D-167		0.2	0.6-	40	134	830
2D-168		0.1	0.6-	30	103	550
2D-169		0.2	0.7-	39	128	640
2D-170		0.2	0.6-	40	113	610
2D-171		0.1	0.5-	27	95	360

Project: Richmond Harbor — Dated 9 & 10 August 1978

Type Standard Elutriate

Sample NO.	Depth	Mercury	Cadmuim	Lead	Zinc	Oil & Grease
2D-161		0.0005	0.0005	0.006	0.027	1.0
2D-162		0.0005	0.0005	0.006	0.027	1.0
2D-163		0.0005	0.0005	0.006	0.027	1.0
2D-164		0.0005	0.0005	0.006	0.027	1.0
2D-165		0.0005	0.0005	0.006	0.027	1.0
2D-166		0.0005	0.0005	0.006	0.027	1.0
2D-167		0.0005	0.0005	0.006	0.027	1.0
2D-168		0.0005	0.0005	0.006	0.027	1.0
2D-169		0.0005	0.0005	0.006	0.027	1.0
2D-170		0.0005	0.0005	0.006	0.027	1.0
2D-171		0.0005	0.0005	0.006	0.027	1.0
Dredge site water		0.0005	0.0003-	0.006-	0.034	1.2
Alcatraz disposal site water		0.0005	0.0005	0.006	0.027	1.0

Project: Oakland Inner & Outer Harbor   Date 7 & 8 August 1978

Type Bulk Sediment

Sample NO.	Depth	Mercury	Cadmuim	Lead	Zinc	Oil & Grease
2D-203		1.0	1.6	131	179	
2D-204		0.1	0.4-	14		190
2D-205		0.4	0.6-	67	162	1110
2D-206		0.4	0.6	70	168	1190
2D-207		0.4	0.6	62	166	1270
2D-208		0.3	0.6-	58	158	1800
2D-209		0.3	0.7-	61	17-	1450
2D-210		0.4	0.6	59	146	1600
2D-211		0.2	0.7-	48	150	1400
2D-212		0.2	0.7-	47	139	1180
2D-169		0.3	0.8	71	193	1700
2D-170		0.3	0.7-	75	183	2380
2D-171		0.3	0.8-	57	153	1190
2D-172		0.2	0.8-	63	163	1180
2D-173		0.2	0.7-	46	119	690
2D-174		0.1	0.5-	23	71	660

Project: Oakland Inner & Outer Harbor   Date 7 & 8 August 1978

Type Standard Elutriate

Sample NO.	Depth	Mercury	Cadmuim	Lead	Zinc	Oil & Grease
2D-203		0.0005	0.0005	0.006	0.027	1.0
2D-204		0.0005	0.0005	0.006	0.027	1.0
2D-205		0.0005	0.0005	0.006	0.027	1.0
2D-206		0.0005	0.0005	0.006	0.027	1.0
2D-207		0.0005	0.0005	0.006	0.027	1.0
2D-208		0.0005	0.0005	0.006	0.027	1.0
2D-209		0.0005	0.0005	0.006	0.027	1.0
2D-210		0.0005	0.0005	0.006	0.027	1.0
2D-211		0.0005	0.0005	0.006	0.027	1.0
2D-212		0.0005	0.0005	0.006	0.027	1.0
2D-169		0.0005	0.0005	0.006	0.027	1.0
2D-170		0.0005	0.0005	0.006	0.027	1.0
2D-171		0.0005	0.0005	0.006	0.027	1.0
2D-172		0.0005	0.0005	0.006	0.027	1.0
2D-173		0.0005	0.0005	0.006	0.027	1.0
2D-174		0.0005	0.0005	0.006	0.027	1.0
Dredge site water						
Oakland Inner Harbor		0.0004	0.0007	0.006-	0.031	1.0
Oakland Outer Harbor		0.0005	0.0003-	0.006-	0.034	1.2
Alcatraz disposal site		0.0005	0.0005	0.006	0.027	1.0

Project: Alameda Naval Air Station Date 21 February 1978

Type Bulk Sediment

Sample NO.	Depth	Mercury	Cadmuim	Lead	Zinc	Oil & Grease
2D-40	0.0-3.0'	0.3	0.5	60	140	1200
2D-41	0.0-3.0'	0.3	0.5-	61	160	1910
2D-42	0.0-3.0'	0.2	0.5-	57	150	1200
2D-43	0.0-3.0'	0.2	0.5-	48	130	1130
2D-44	0.0-3.0'	0.3	0.6	53	130	1350
2D-45	0.0-3.0'	0.2	0.5	46	120	1170
2D-46	0.0-3.0'	0.3	0.5-	55	140	990
2D-47	0.0-3.0'	0.2	0.5-	46	130	508
2D-48	0.0-3.0'	0.2	0.5-	43	120	1450
2D-49	0.0-3.0'	0.1	0.5-	8	28	20
2D-50	0.0-3.0'	0.2	0.5-	34	87	634
2D-51	0.0-3.0'	0.1	0.5	19	48	322

Project: Alameda Naval Air Station Date 21 February 1978

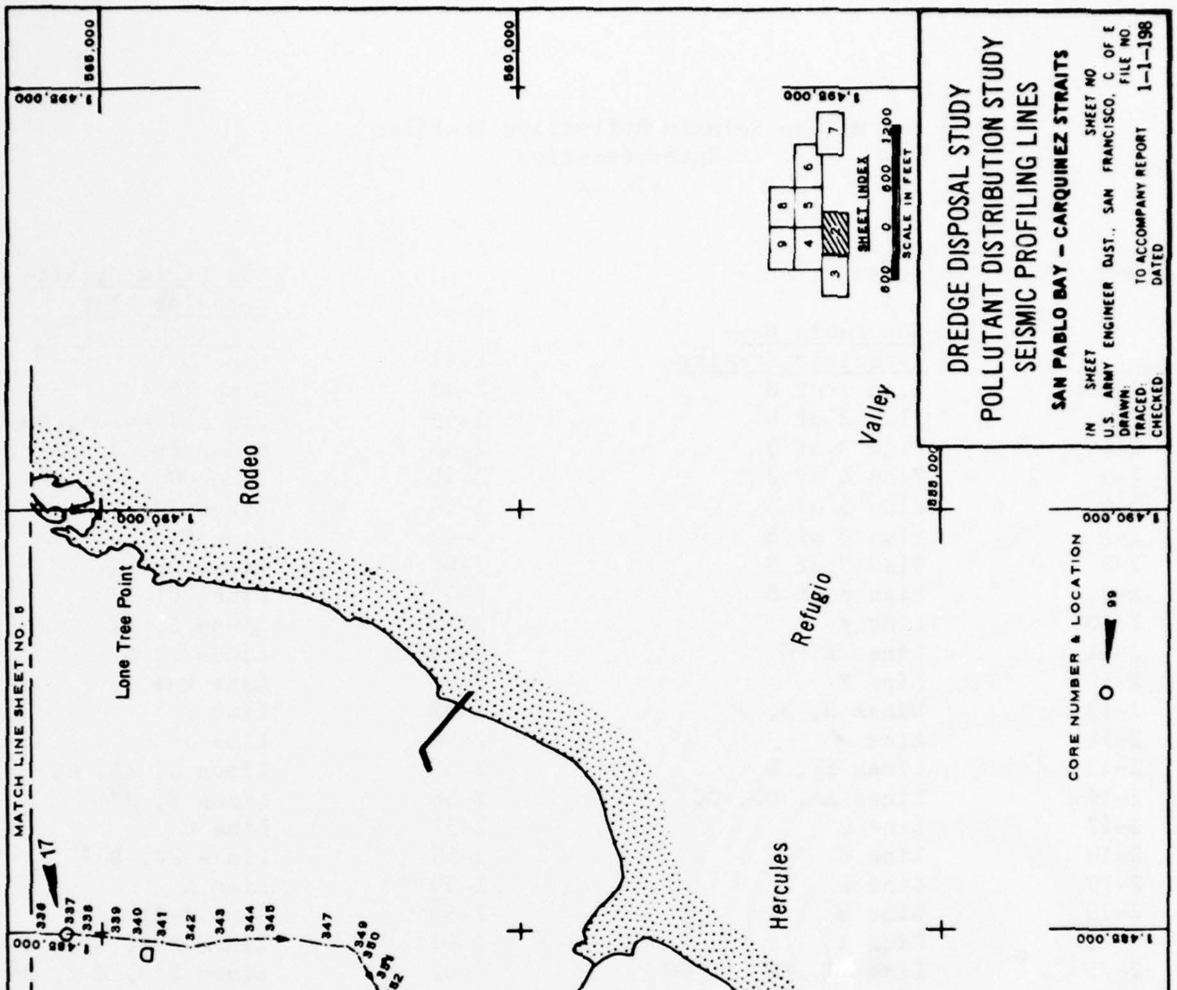
Type Liquid Phase Analysis

Sample NO.	Depth	Mercury	Cadmuim	Lead	Zinc	Oil & Grease
2D-40	0.0-3.0'	0.0001	0.0003	0.003-	0.030	0.8
2D-41	0.0-3.0'	0.0001	0.0003	0.003-	0.030	0.8
2D-42	0.0-3.0'	0.0001	0.0003	0.003-	0.030	0.8
2D-43	0.0-3.0'	0.0001	0.0003	0.003-	0.030	0.8
2D-44	0.0-3.0'	0.0001	0.0003	0.003-	0.030	0.8
2D-45	0.0-3.0'	0.0001	0.0003	0.003-	0.030	0.8
2D-46	0.0-3.0'	0.0001	0.0003	0.003-	0.030	0.8
2D-47	0.0-3.0'	0.0001	0.0003	0.003-	0.030	0.8
2D-48	0.0-3.0'	0.0001	0.0003	0.003-	0.030	0.8
2D-49	0.0-3.0'	0.0001	0.0003	0.003-	0.030	0.8
2D-50	0.0-3.0'	0.0001	0.0003	0.003-	0.030	0.8
2D-51	0.0-3.0'	0.0001	0.0003	0.003-	0.030	0.8
Dredge site water		0.0001	0.0005	0.011	0.033	0.6
Standard elutriate		0.0001	0.0003	0.003-	0.030	0.8

INCLOSURE 2

SEISMIC REFLECTION PROFILES
INTERPRETATIONS

Marine Seismic Reflection Profiles
Interpretation
Index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POLLUTANT DISTRIBUTION STUDY
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U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E
SHEET NO
FILE NO
1-1-198
DRAWN:
TRACED:
CHECKED:
TO ACCOMPANY REPORT
DATED
SHEET INDEX
SCALE IN FEET
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CORE NUMBER & LOCATION
MATCH LINE SHEET NO. 5
MATCH LINE SHEET NO. 4
MATCH LINE SHEET NO. 3
Rodeo
Lone Tree Point
Valley
Refugio
Hercules
Pinole
D
DD
C
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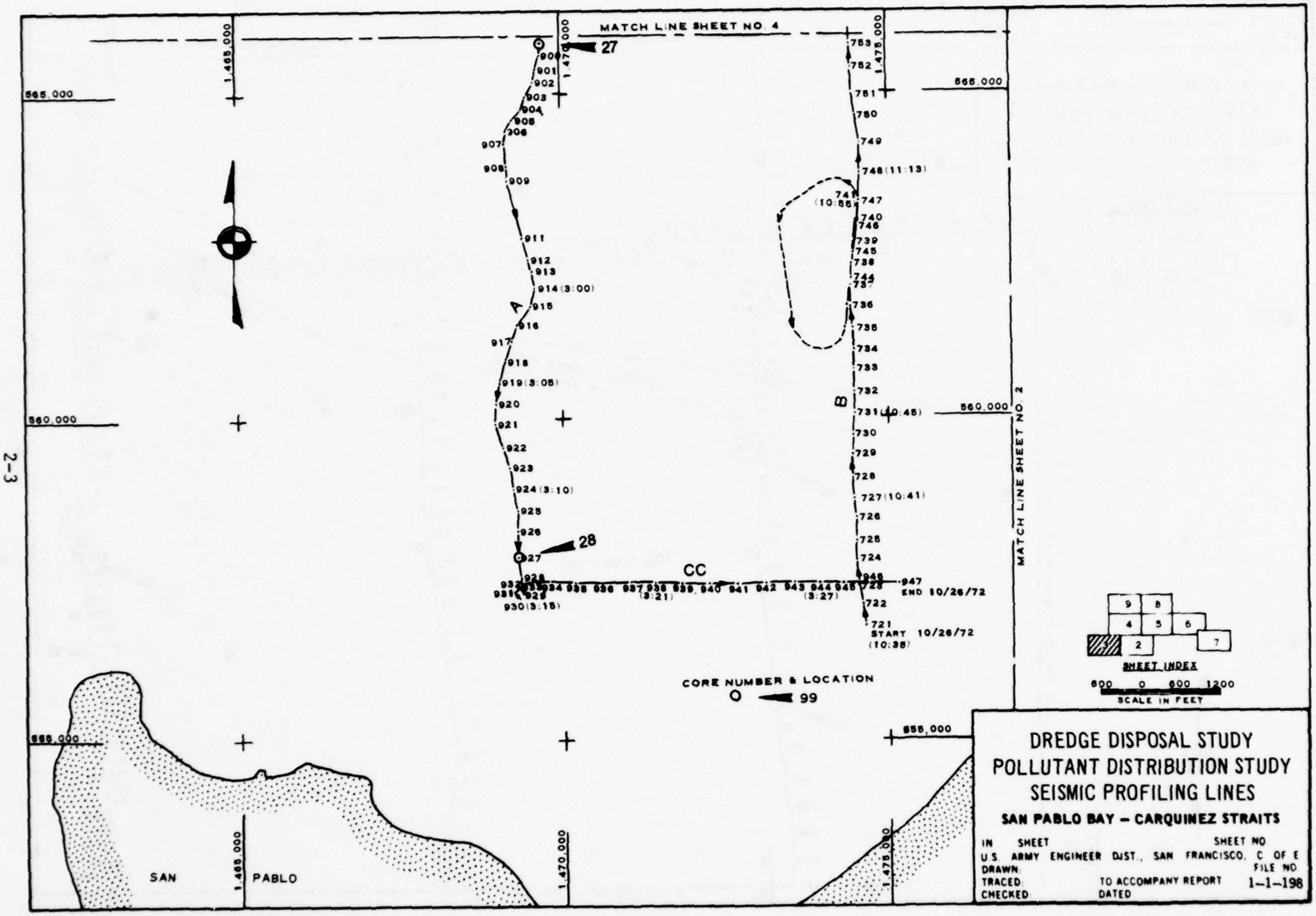
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POLLUTANT DISTRIBUTION STUDY
SEISMIC PROFILING LINES
SAN PABLO BAY – CARQUINEZ STRAITS
IN SHEET
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U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E
DRAWN:
TRACED:
CHECKED:
FILE NO
TO ACCOMPANY REPORT
DATED
1-1-198
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MATCH LINE SHEET NO. 2
SHEET INDEX
SCALE IN FEET
600 0 600 1200
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28
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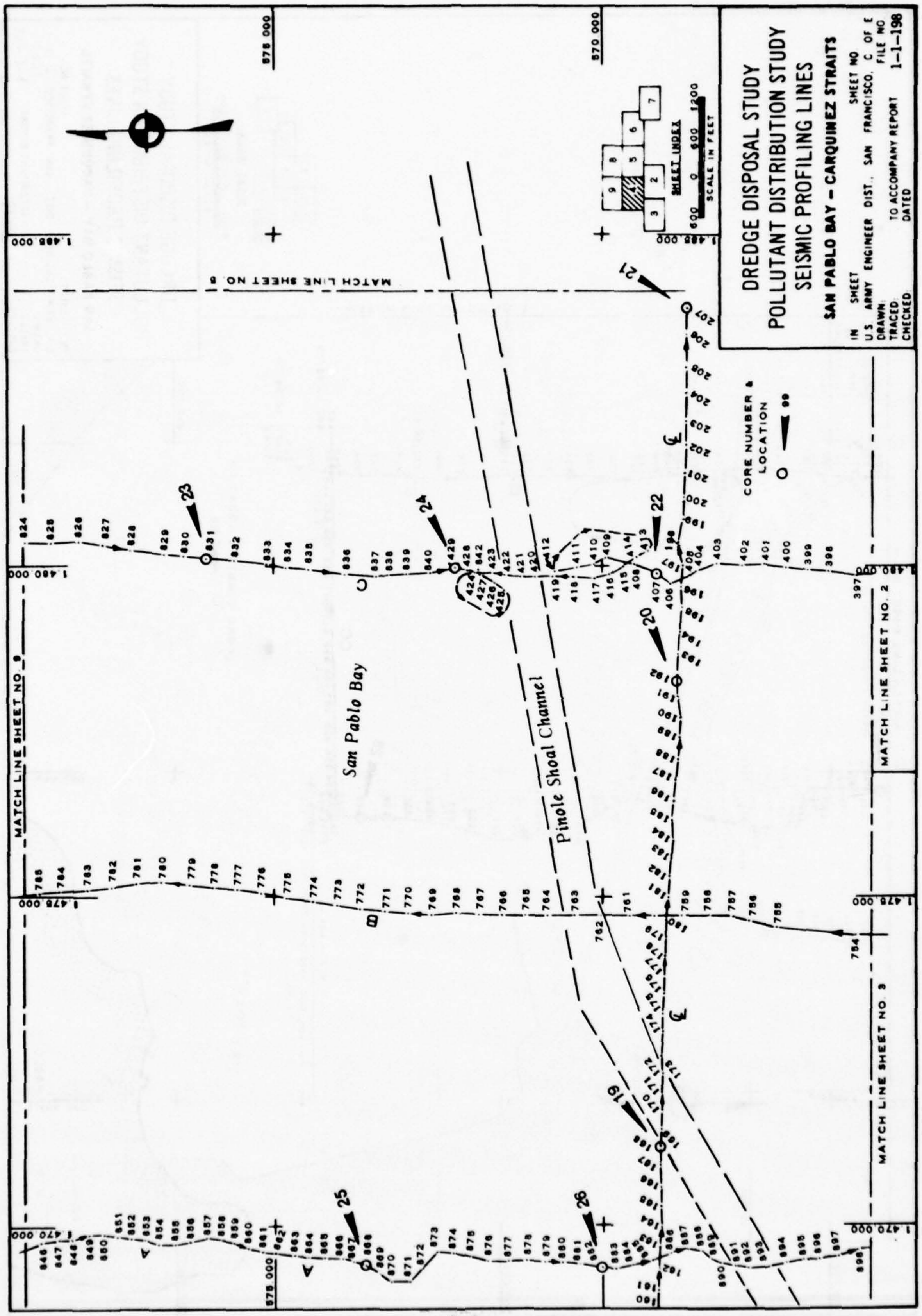
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DRAWN: FILE NO
TRACED: TO ACCOMPANY REPORT 1-1-198
CHECKED: DATED
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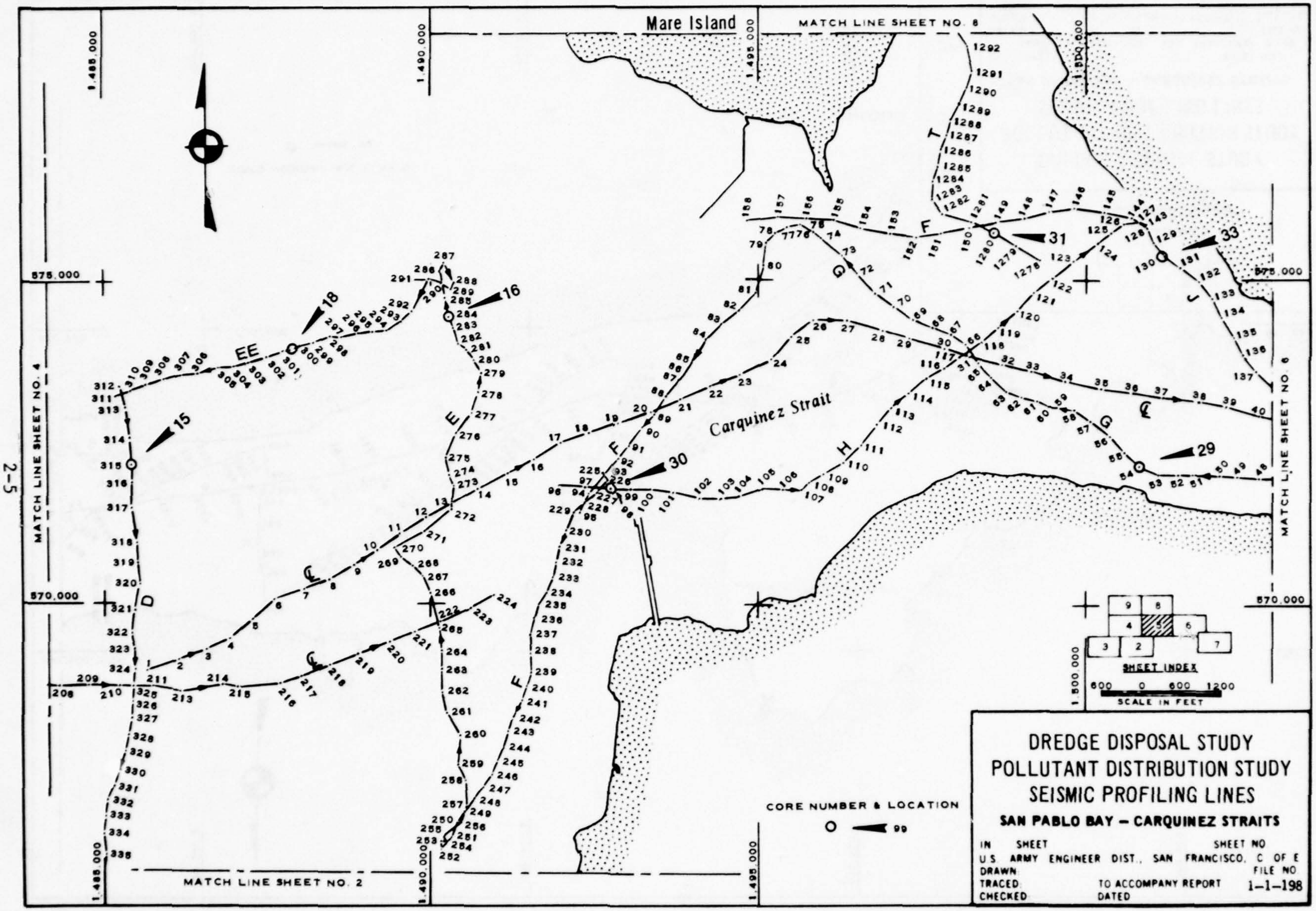

DREDGE DISPOSAL STUDY
POLLUTANT DISTRIBUTION STUDY
SEISMIC PROFILING LINES
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U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E
DRAWN FILE NO
TRACED TO ACCOMPANY REPORT 1-1-198
CHECKED DATED
Mare Island
Carquinez Strait
MATCH LINE SHEET NO. 8
MATCH LINE SHEET NO. 6
MATCH LINE SHEET NO. 4
MATCH LINE SHEET NO. 2
CORE NUMBER & LOCATION
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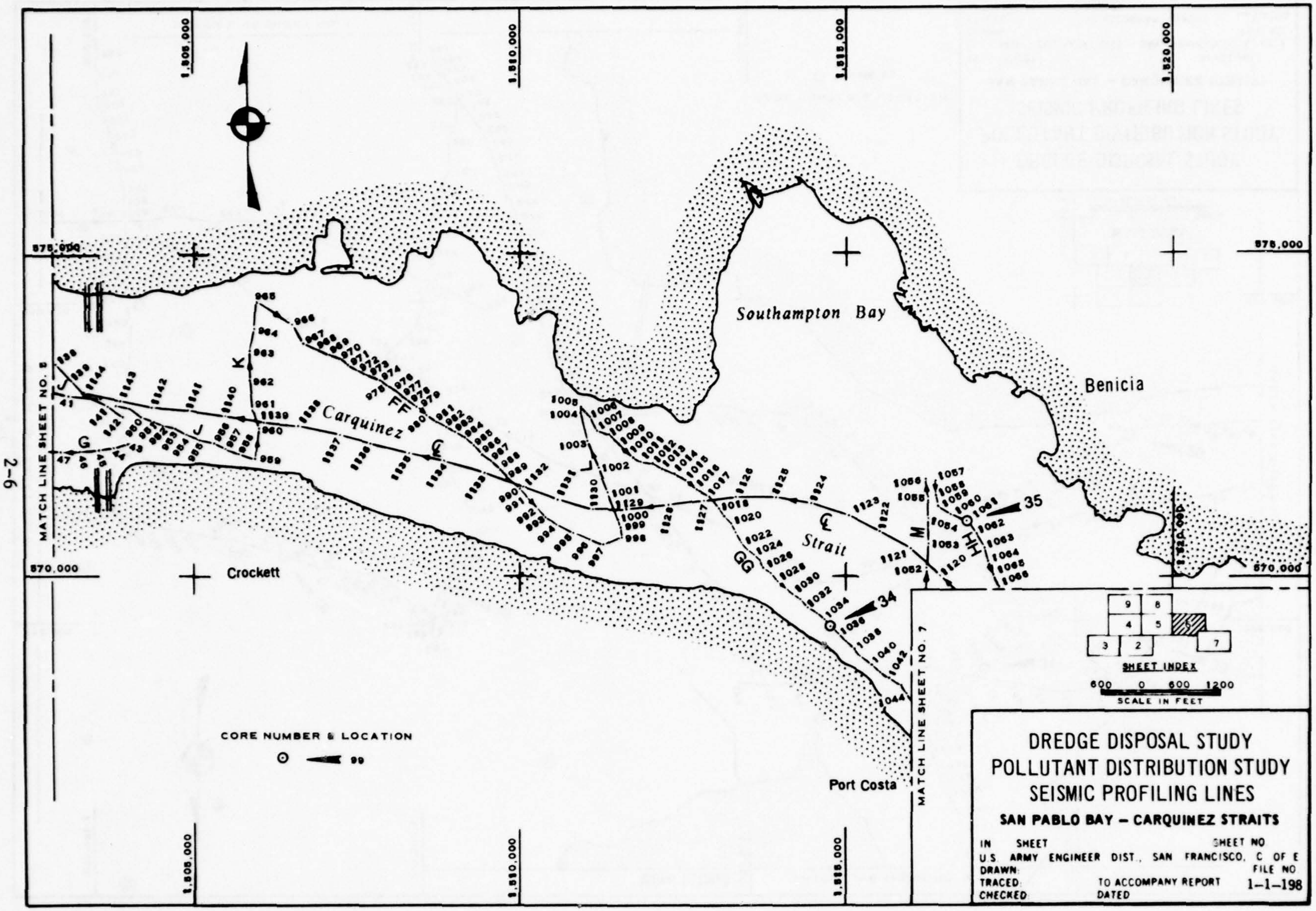
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POLLUTANT DISTRIBUTION STUDY
SEISMIC PROFILING LINES
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U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E
FILE NO
DRAWN:
TRACED:
TO ACCOMPANY REPORT
1-1-198
CHECKED:
DATED
SHEET INDEX
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SCALE IN FEET
CORE NUMBER & LOCATION
Southampton Bay
Benicia
Carquinez
Strait
Crockett
Port Costa
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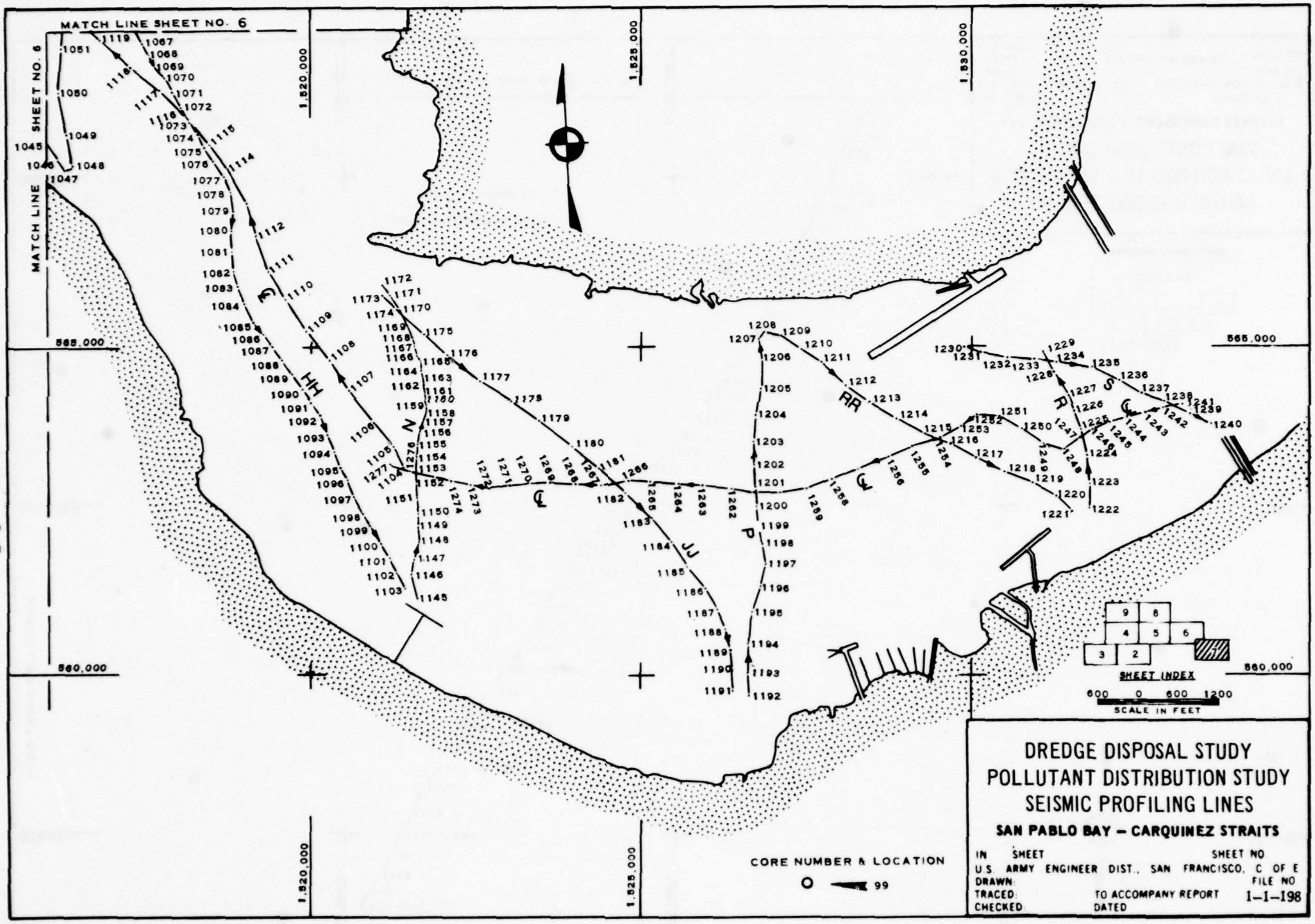

DREDGE DISPOSAL STUDY
POLLUTANT DISTRIBUTION STUDY
SEISMIC PROFILING LINES
SAN PABLO BAY – CARQUINEZ STRAITS

IN SHEET SHEET NO
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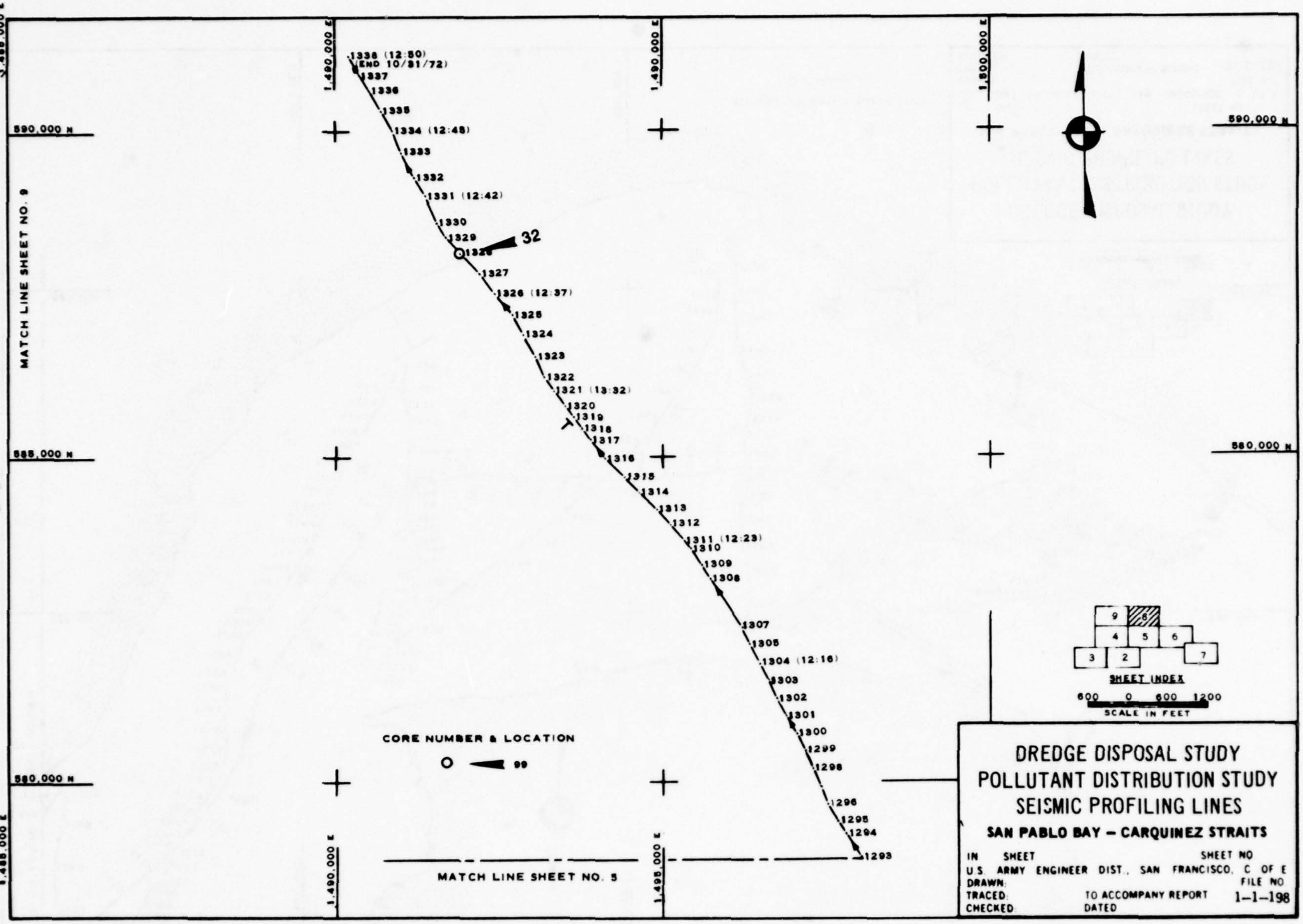
CHECKED: DATED


DREDGE DISPOSAL STUDY
POLLUTANT DISTRIBUTION STUDY
SEISMIC PROFILING LINES
SAN PABLO BAY – CARQUINEZ STRAITS
IN SHEET
SHEET NO
U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E
DRAWN:
FILE NO
TRACED:
TO ACCOMPANY REPORT
1-1-198
CHECKED
DATED
SHEET INDEX
600 0 600 1200
SCALE IN FEET
CORE NUMBER & LOCATION
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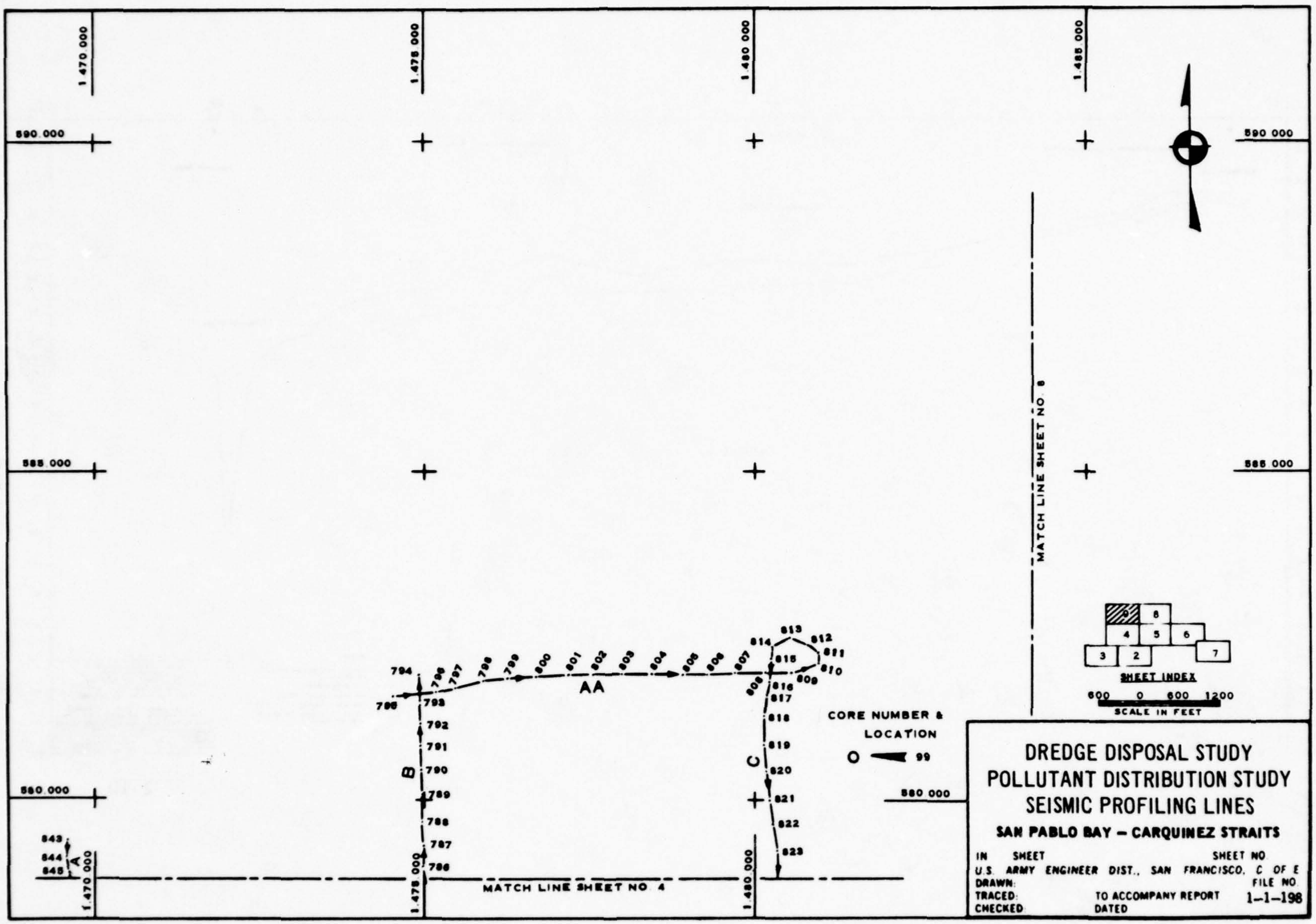
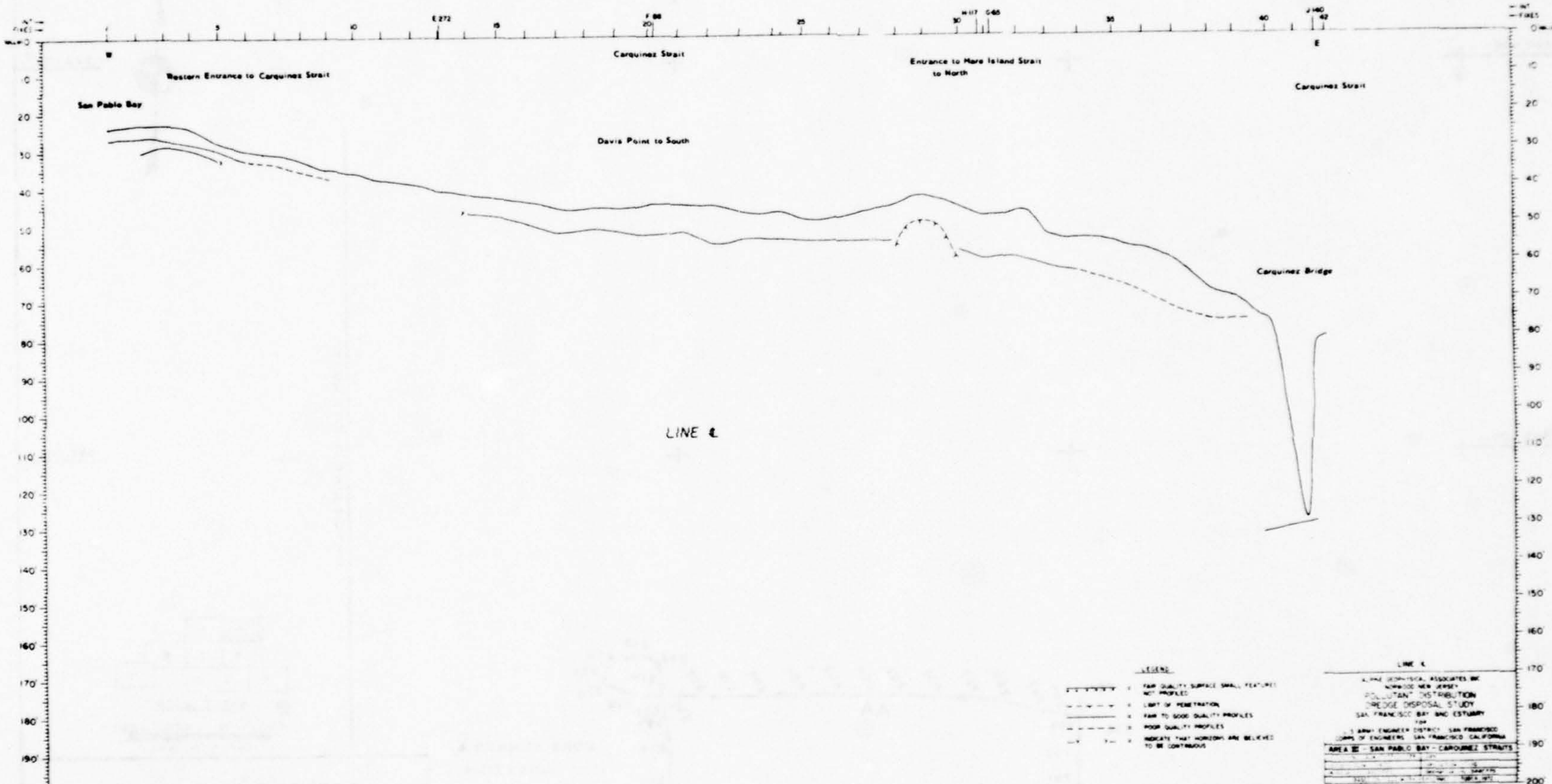
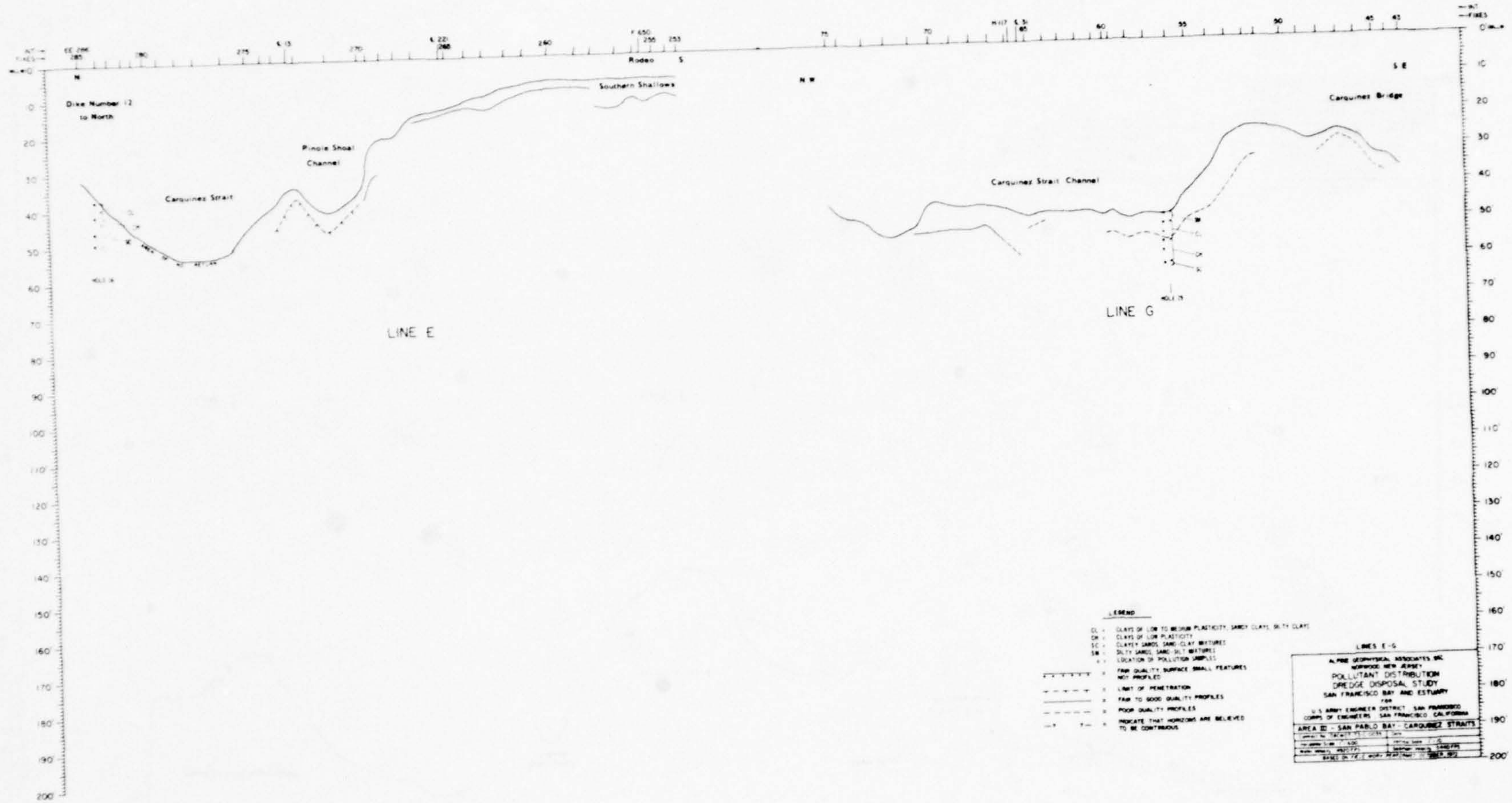
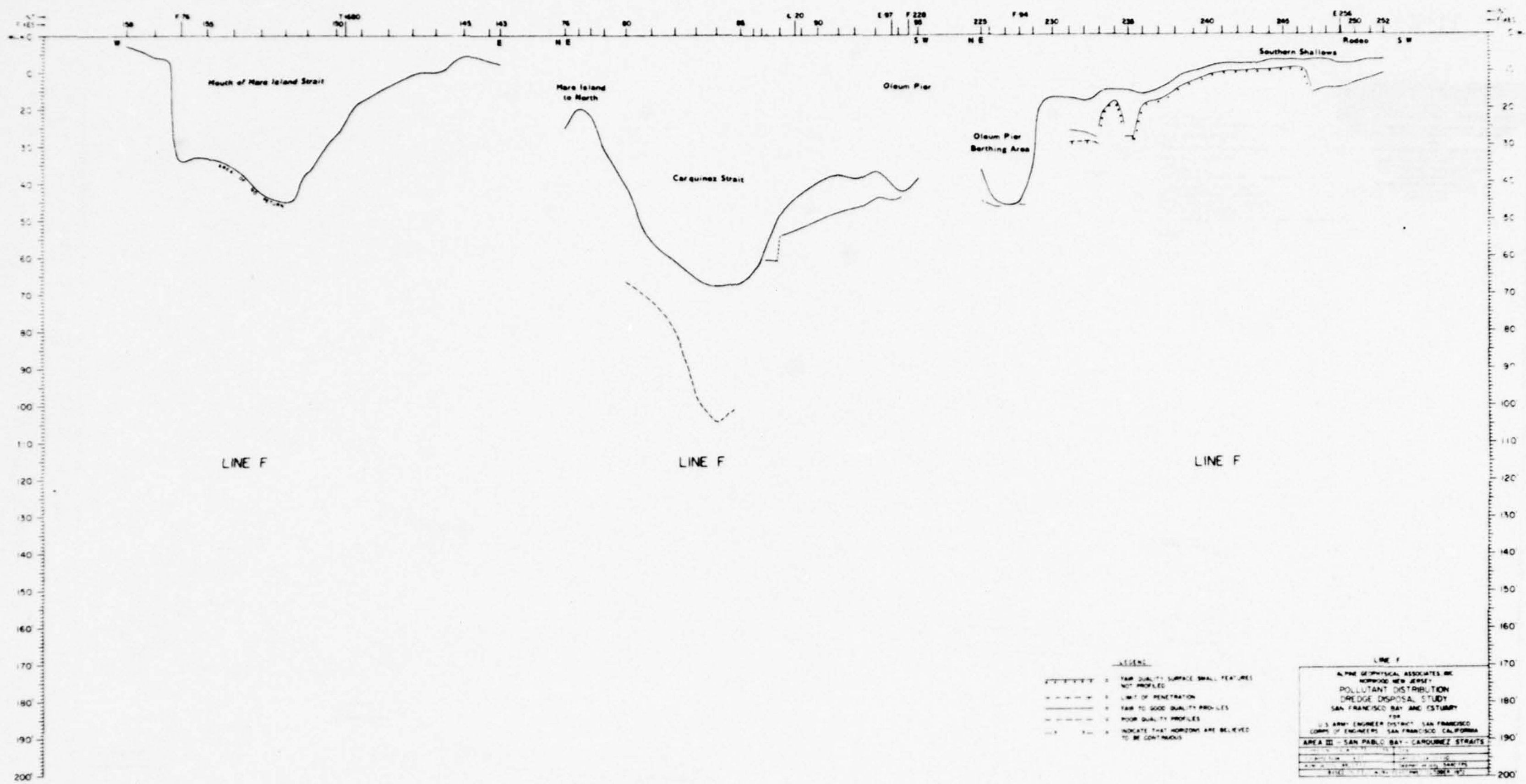
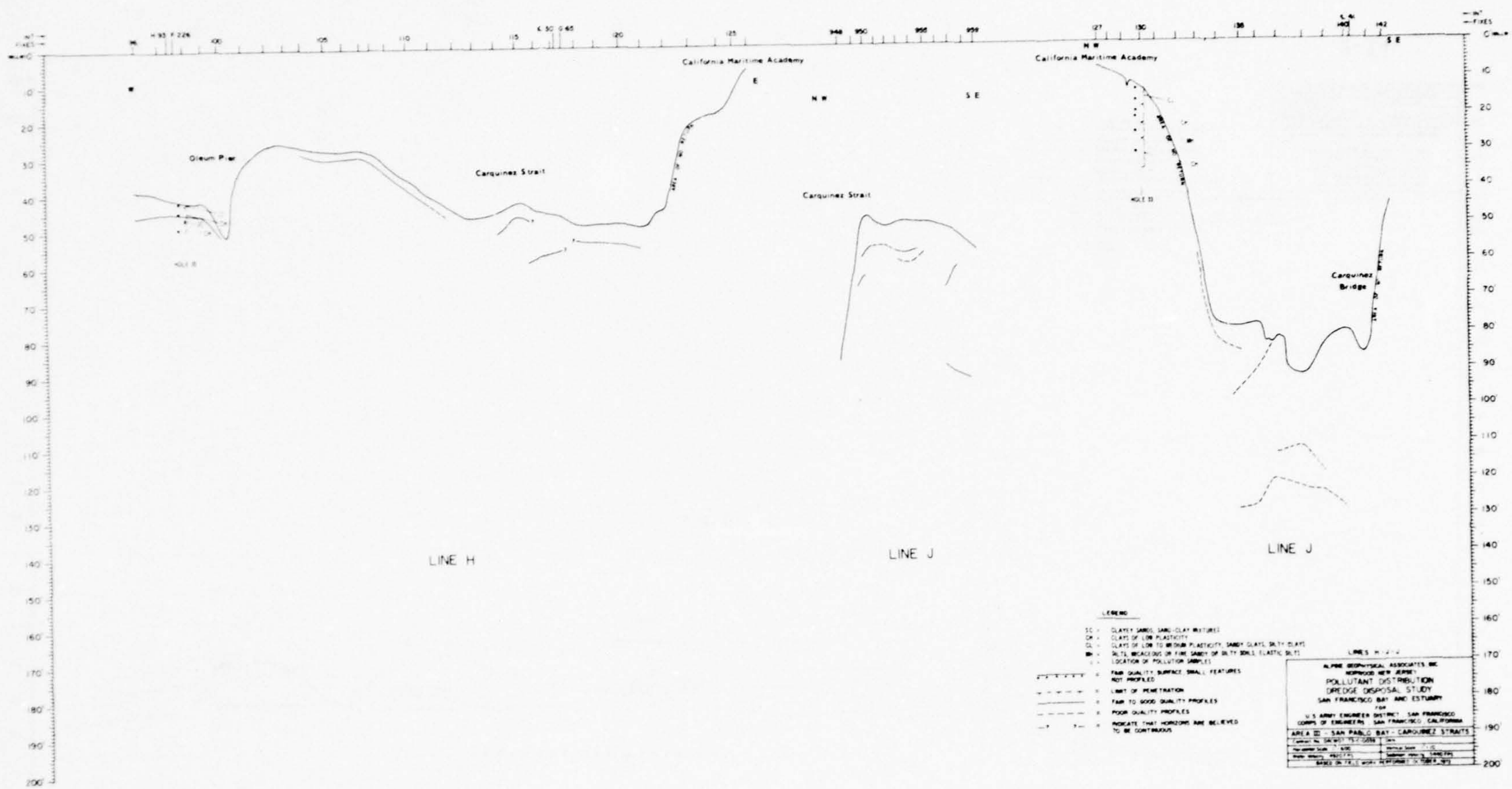
1294
1293


DREDGE DISPOSAL STUDY
POLLUTANT DISTRIBUTION STUDY
SEISMIC PROFILING LINES
SAN PABLO BAY – CARQUINEZ STRAITS
IN SHEET SHEET NO.
U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C. OF E.
DRAWN: FILE NO.
TRACED: TO ACCOMPANY REPORT 1-1-198
CHECKED DATED
SHEET INDEX
600 0 600 1200
SCALE IN FEET
CORE NUMBER & LOCATION
99
MATCH LINE SHEET NO. 8
MATCH LINE SHEET NO. 4
1.470 000
1.475 000
1.480 000
1.485 000
590 000
585 000
580 000
AA
B
C
A

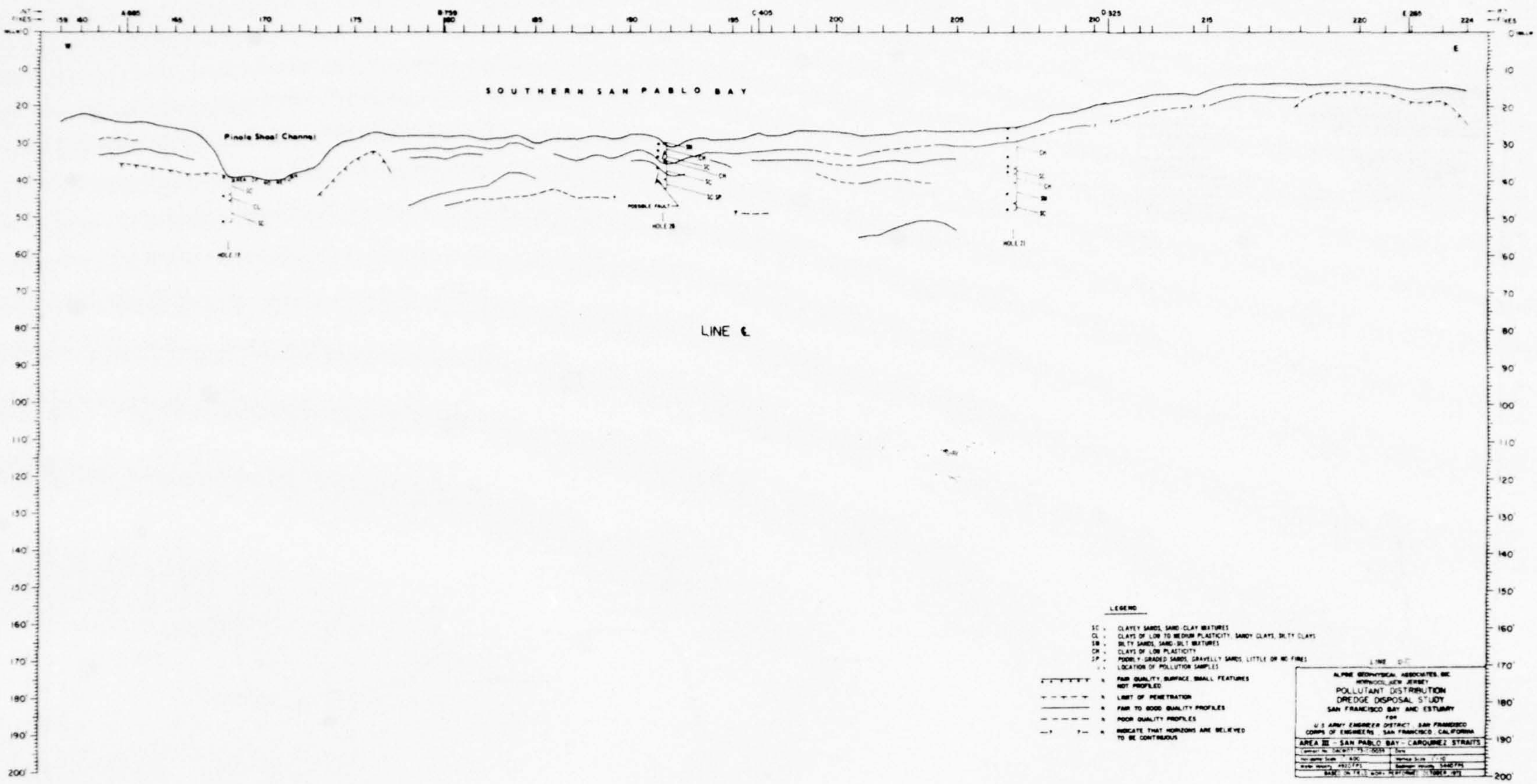

San Pablo Bay
Western Entrance to Carquinez Strait
Carquinez Strait
Davis Point to South
Entrance to Mare Island Strait
to North
Carquinez Strait
Carquinez Bridge
LINE ℄
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
CORPS OF ENGINEERS SAN FRANCISCO CALIFORNIA
AREA III - SAN PABLO BAY - CARQUINEZ STRAITS

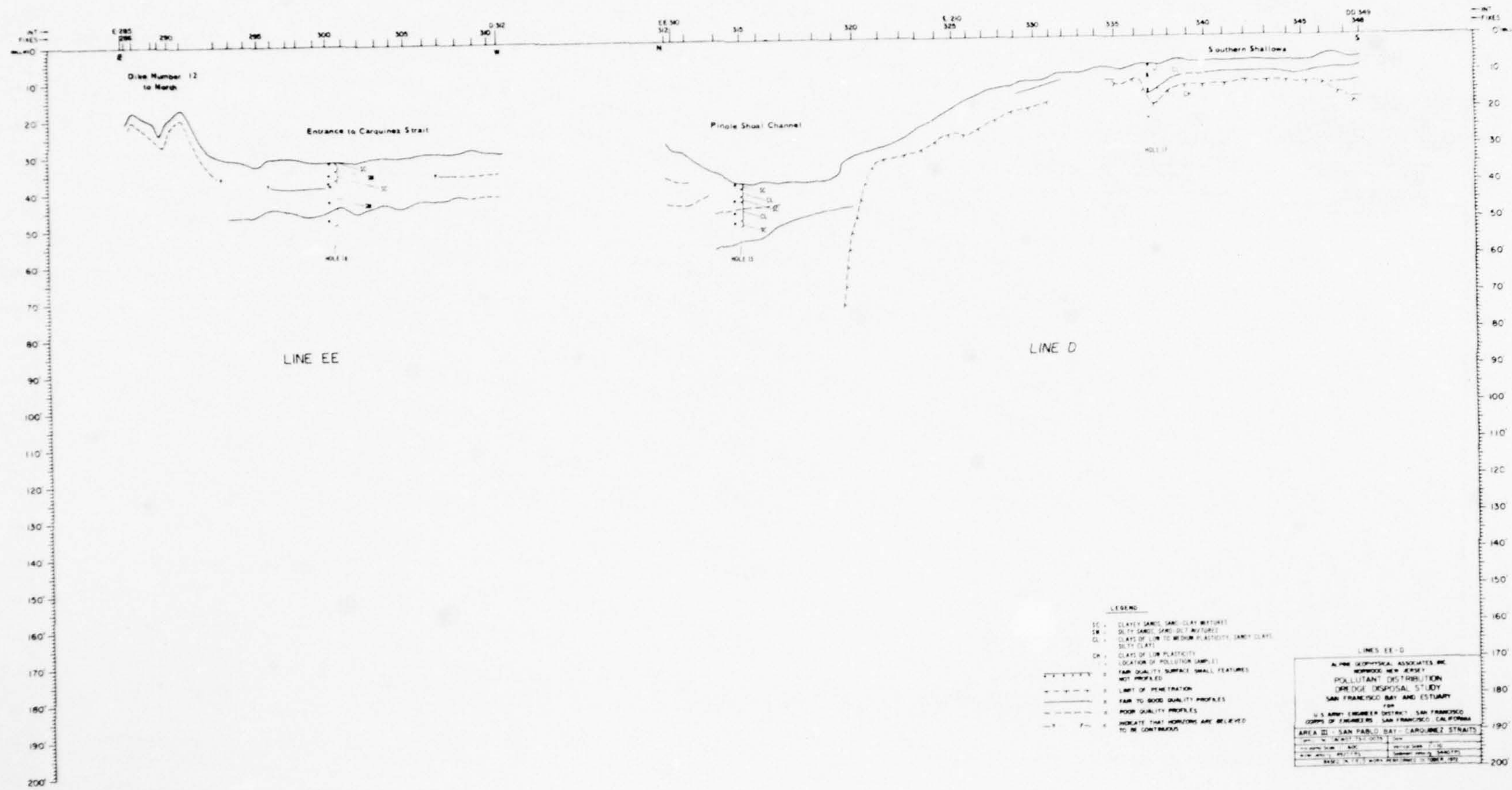

Dike Number 12
to North
Carquinez Strait
Pinole Shoal
Channel
Southern Shallows
Rodeo
LINE E
Carquinez Strait Channel
Carquinez Bridge
LINE G
LEGEND
CL = CLAYS OF LOW TO MEDIUM PLASTICITY, SANDY CLAYS, SILTY CLAYS
CH = CLAYS OF LOW PLASTICITY
SC = CLAYEY SANDS, SAND-CLAY MIXTURES
SM = SILTY SANDS, SAND-SILT MIXTURES
LOCATION OF POLLUTION SAMPLES
FAIR QUALITY, SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINES E-G
ALPINE GEOPHYSICAL ASSOCIATES INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA III - SAN PABLO BAY - CARQUINEZ STRAITS


Mouth of Mare Island Strait
Mare Island to North
Carquinez Strait
Oleum Pier
Oleum Pier Berthing Area
Southern Shallows
Rodeo
LINE F
LINE F
LINE F
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINE F
ALPINE GEOPHYSICAL ASSOCIATES, INC.
NORWOOD, NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA III - SAN PABLO BAY - CARQUINEZ STRAITS

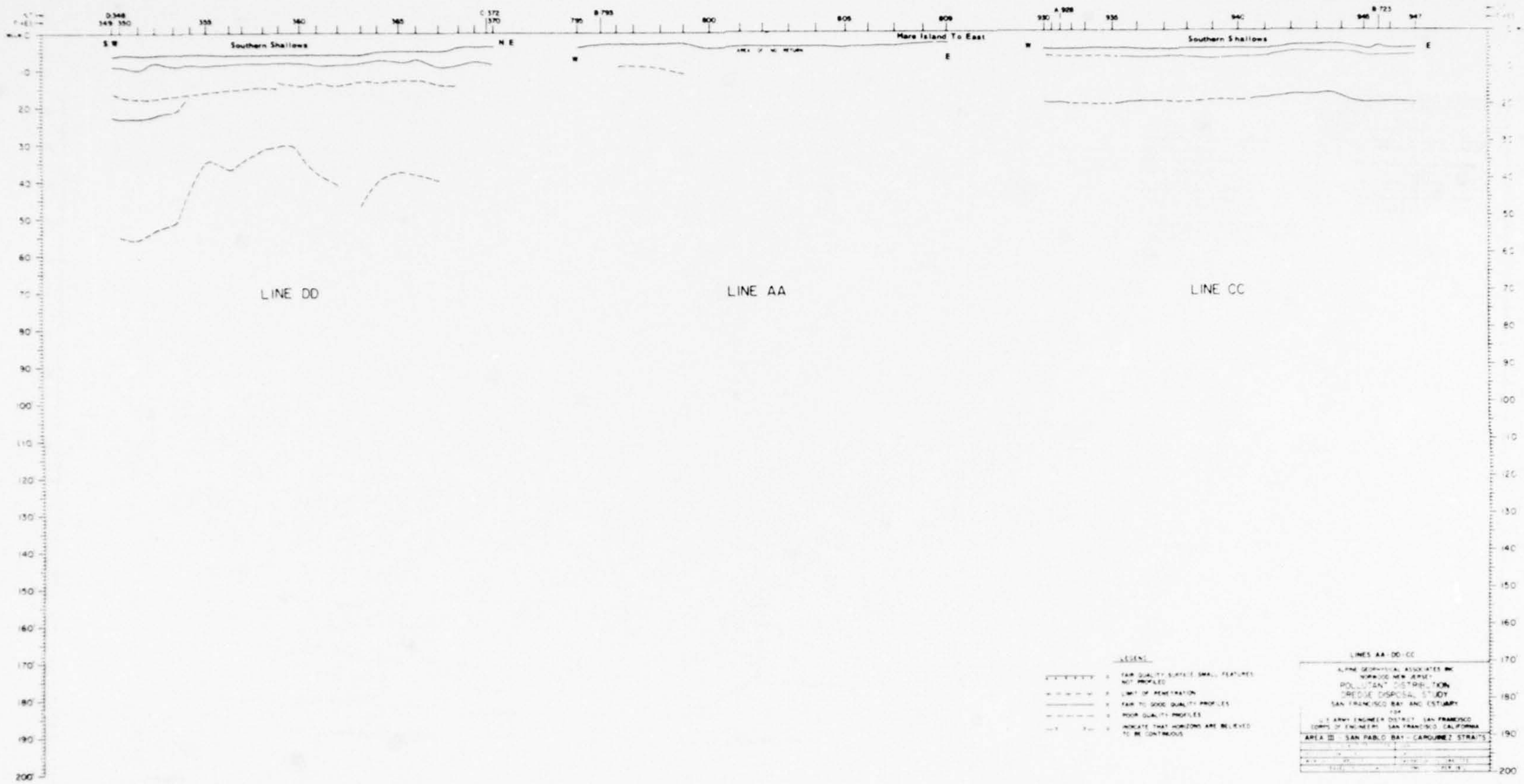


California Maritime Academy
Oleum Pier
Carquinez Strait
Carquinez Strait
California Maritime Academy
Carquinez Bridge
LINE H
LINE J
LINE J
LEGEND
SC = CLAYEY SANDS, SAND-CLAY MIXTURES
CL = CLAYS OF LOW TO MEDIUM PLASTICITY, SANDY CLAYS, SILTY CLAYS
LOCATION OF POLLUTION SAMPLES
FAIR QUALITY SURFACE, SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
ALPINE GEOPHYSICAL ASSOCIATES INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA III - SAN PABLO BAY - CARQUINEZ STRAITS

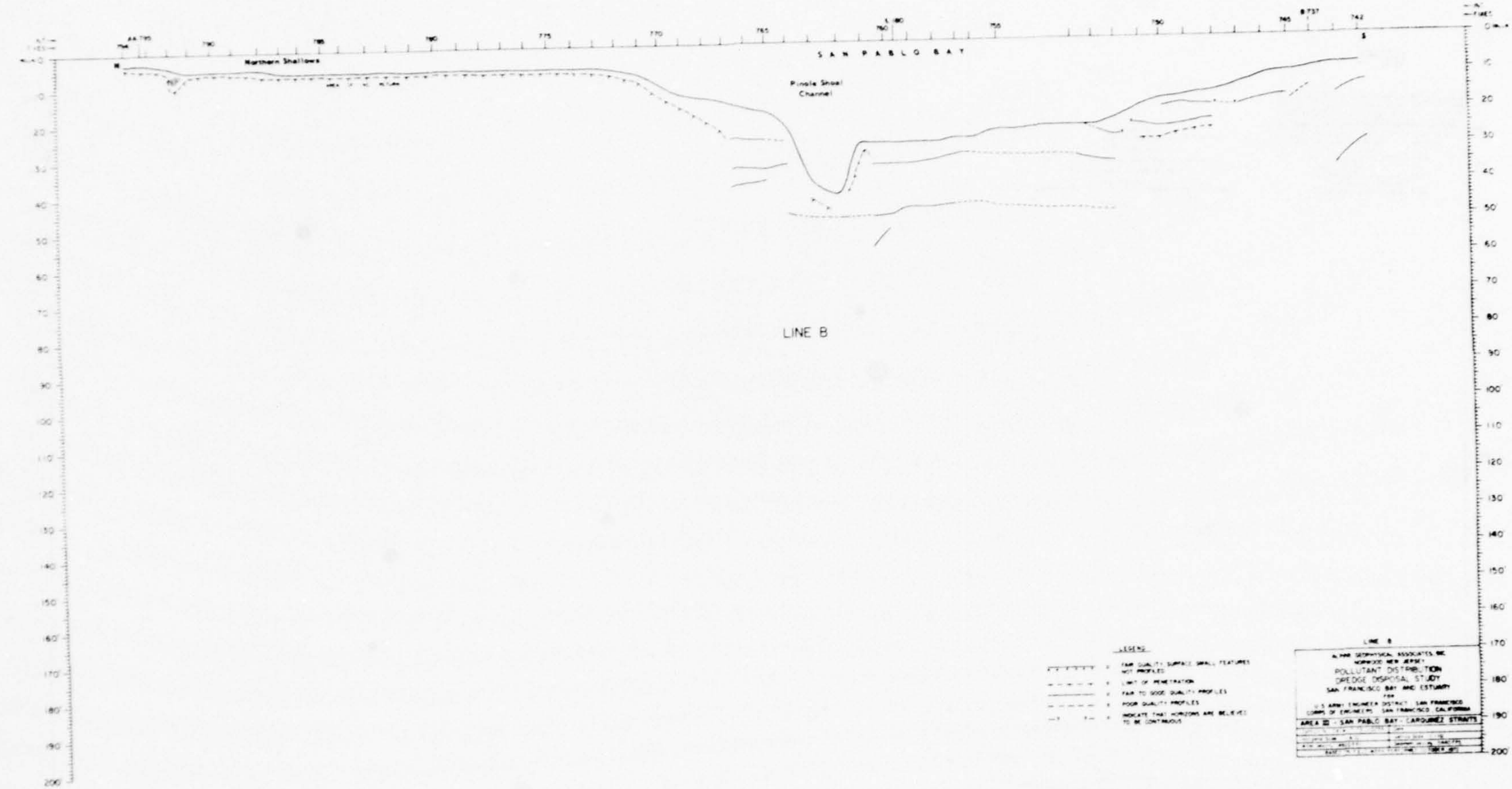

SOUTHERN SAN PABLO BAY
Pinole Shoal Channel
POSSIBLE FAULT
LINE C
LEGEND
SC - CLAYEY SANDS, SAND-CLAY MIXTURES
CL - CLAYS OF LOW TO MEDIUM PLASTICITY, SANDY CLAYS, SILTY CLAYS
SM - SILTY SANDS, SAND-SILT MIXTURES
CH - CLAYS OF LOW PLASTICITY
SP - POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
LOCATION OF POLLUTION SAMPLES
FAIR QUALITY, SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
ALPINE GEOPHYSICAL ASSOCIATES, INC.
NORWOOD, NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA III - SAN PABLO BAY - CARQUINEZ STRAITS

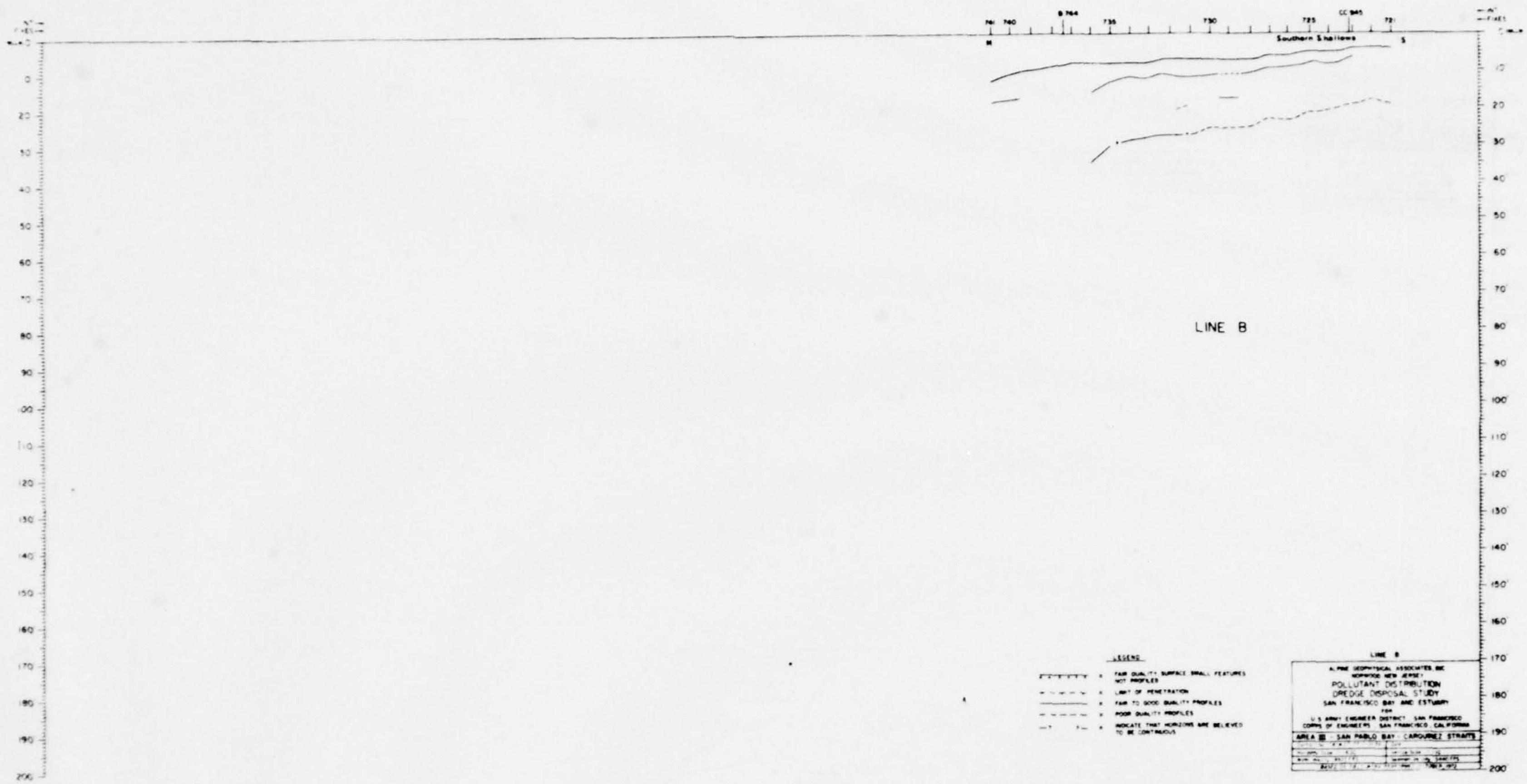


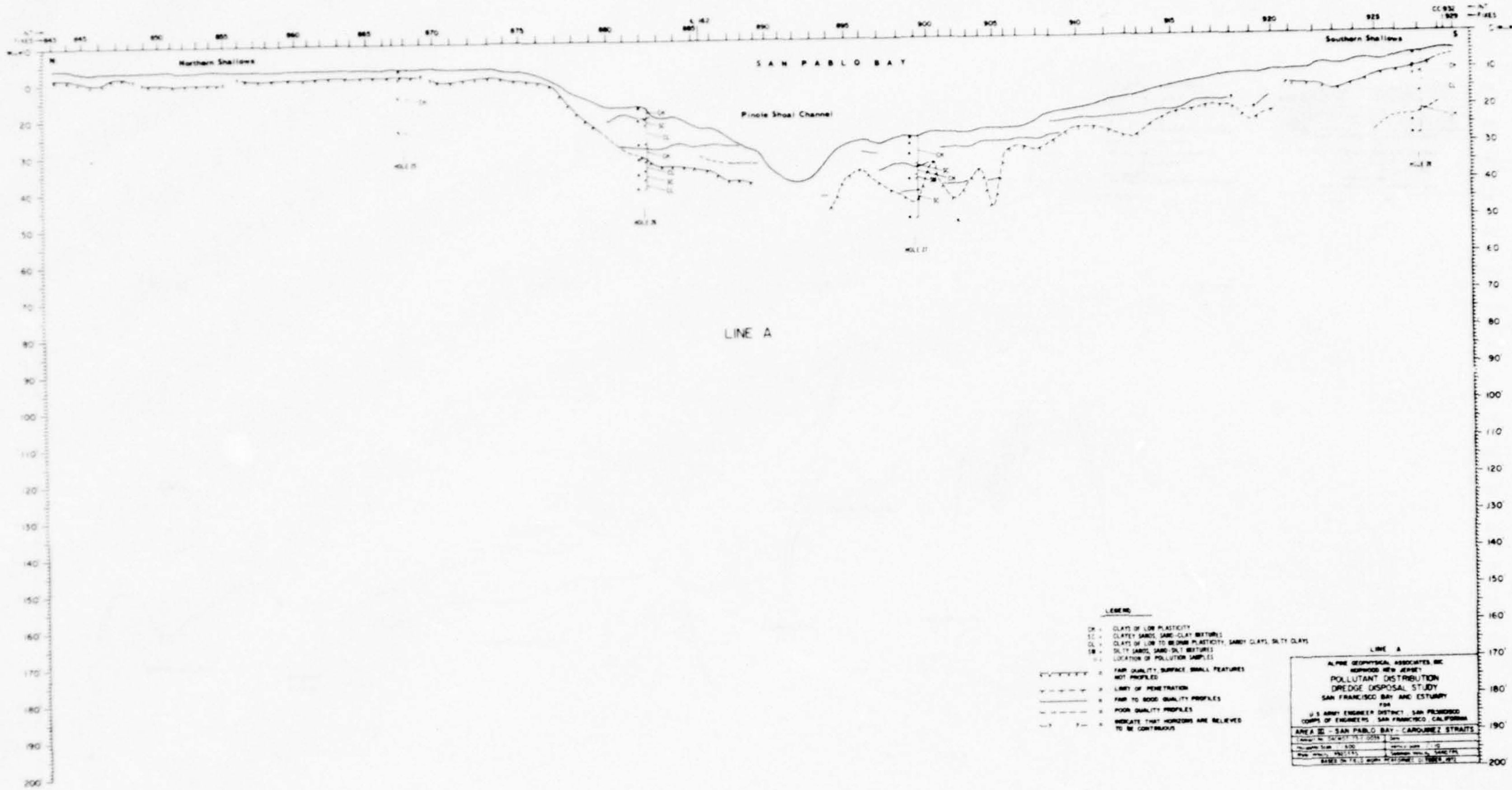
Dike Number 12 to Marsh
Entrance to Carquinez Strait
Pinole Shoal Channel
Southern Shallows
LINE EE
LINE D
LEGEND
SC - CLAYEY SANDS, SAND-CLAY MIXTURES
SM - SILTY SANDS, SAND-SILT MIXTURES
CL - CLAYS OF LOW TO MEDIUM PLASTICITY, SANDY CLAYS, SILTY CLAYS
CH - CLAYS OF LOW PLASTICITY
LOCATION OF POLLUTION SAMPLES
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINES EE-D
ALPINE GEOPHYSICAL ASSOCIATES INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA III - SAN PABLO BAY - CARQUINEZ STRAITS

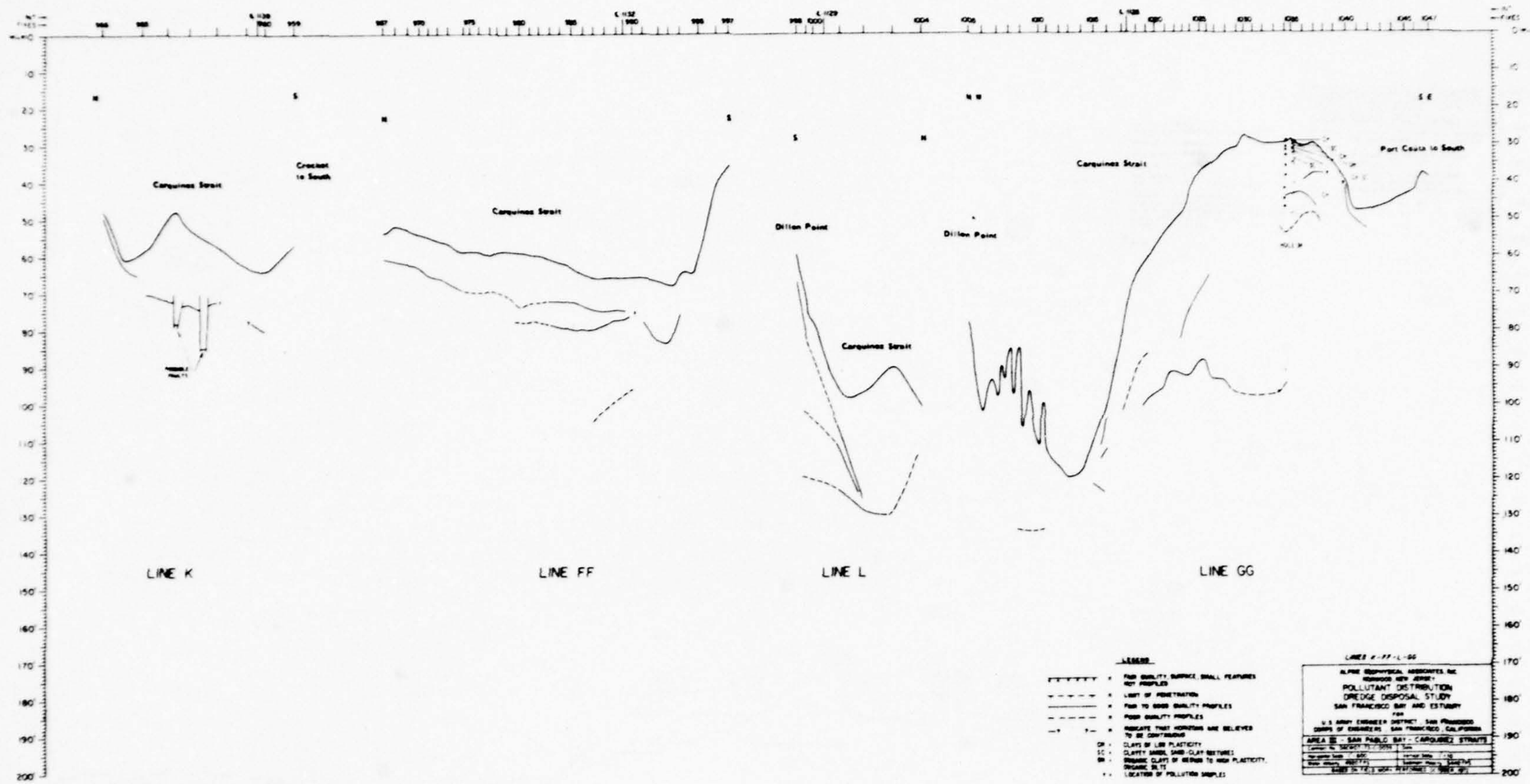


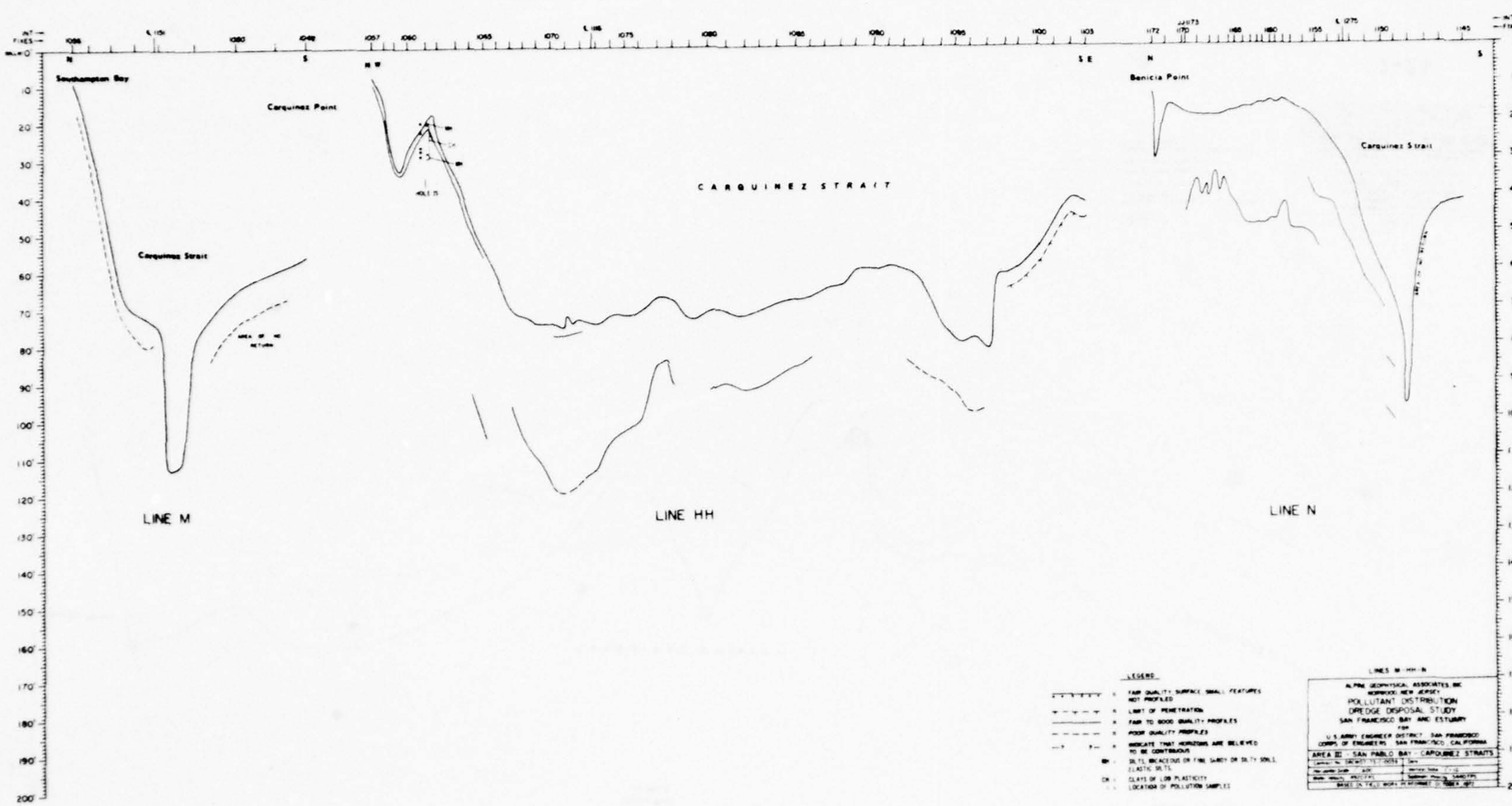
Southern Shallows
Mare Island To East
Southern Shallows
LINE DD
LINE AA
LINE CC
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINES AA · DD · CC
ALPINE GEOPHYSICAL ASSOCIATES INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA III · SAN PABLO BAY · CARQUINEZ STRAITS

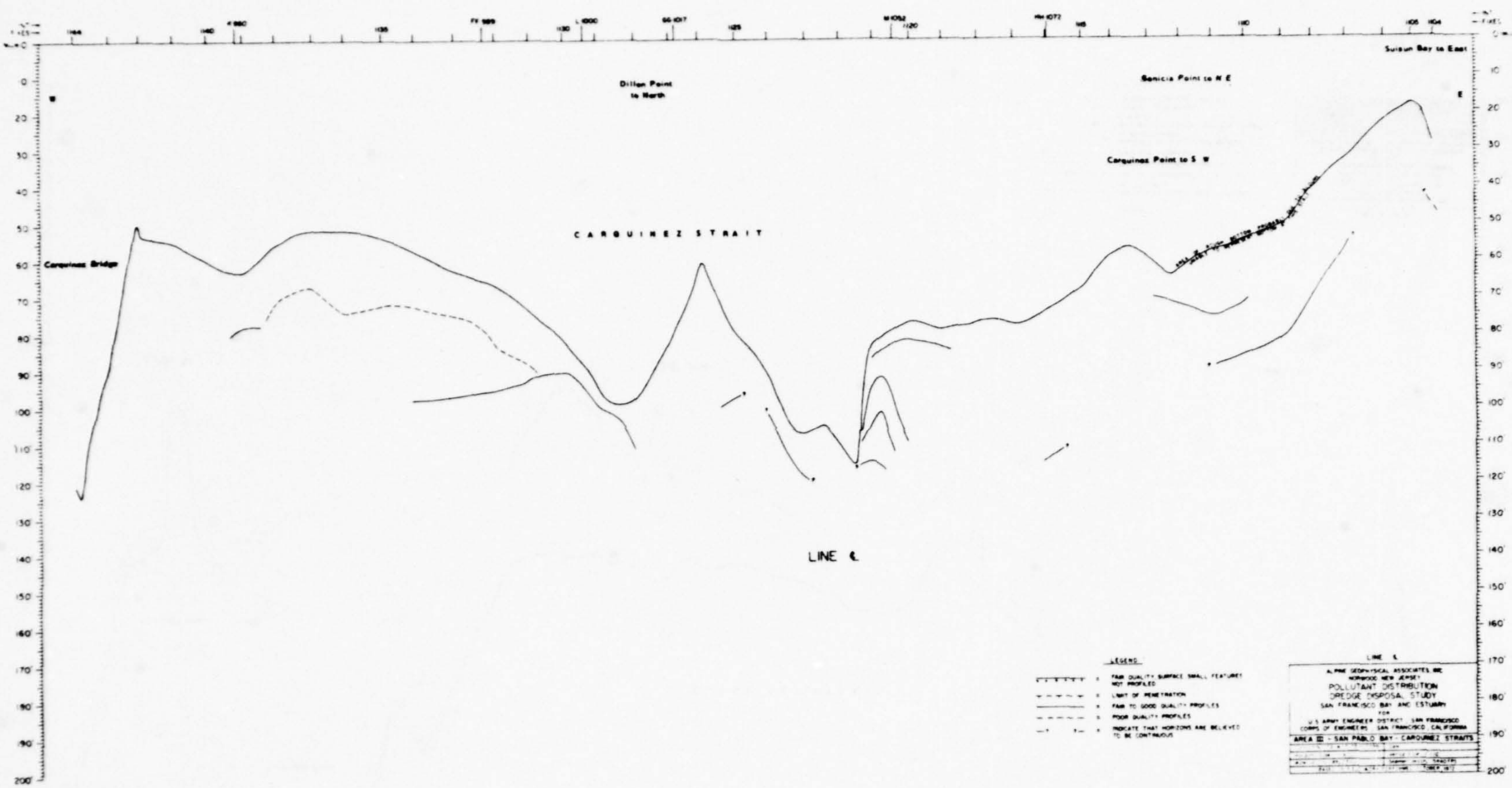

SAN PABLO BAY
Northern Shallows
Pinole Shoal Channel
LINE B
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINE B
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA III - SAN PABLO BAY - CARQUINEZ STRAITS

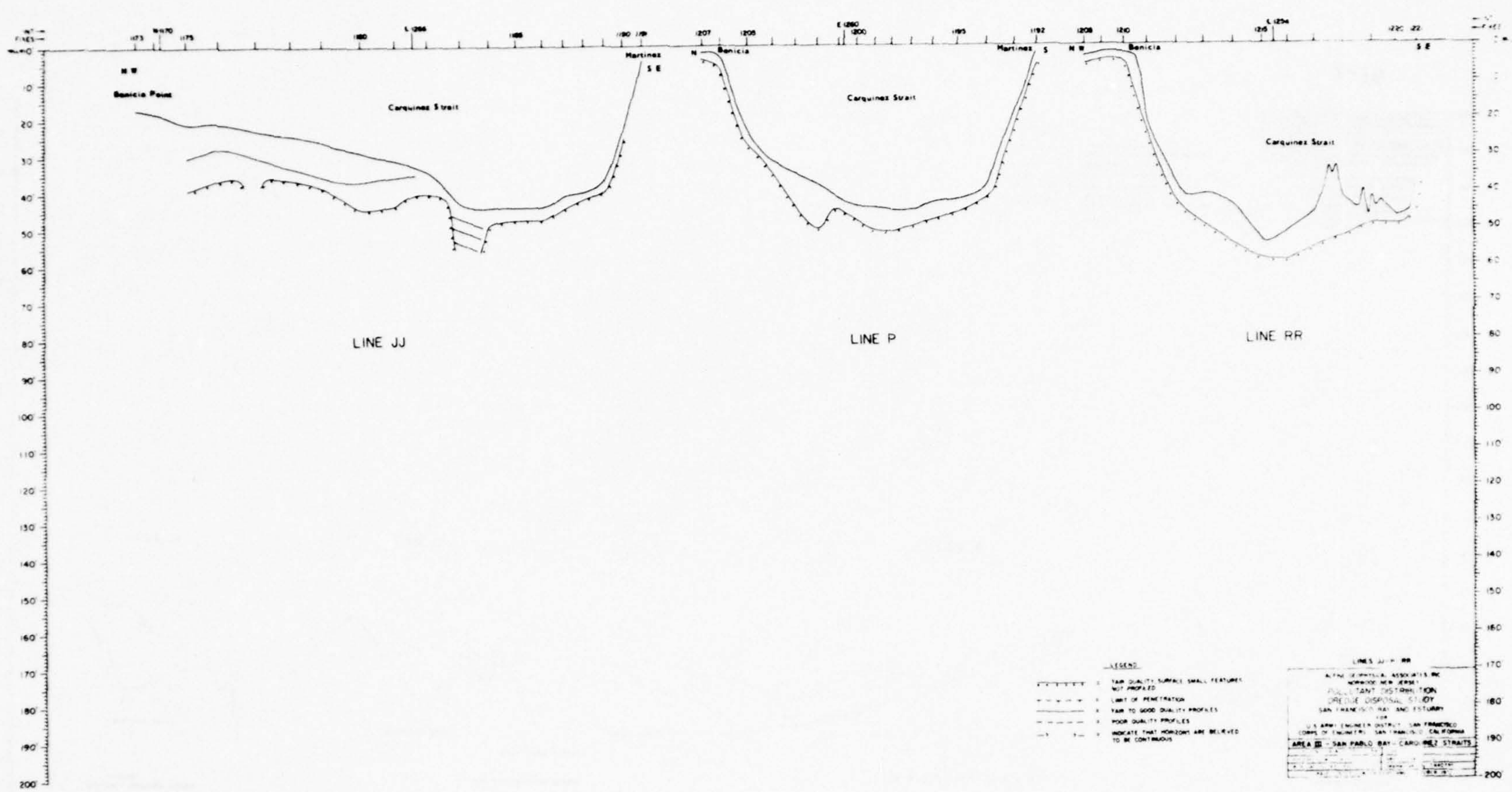

LINE B
Southern Shallows
N
S
740
B 764
735
730
725
CC 945
721
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINE B
ALPINE GEOPHYSICAL ASSOCIATES, INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA III - SAN PABLO BAY - CARQUINEZ STRAITS

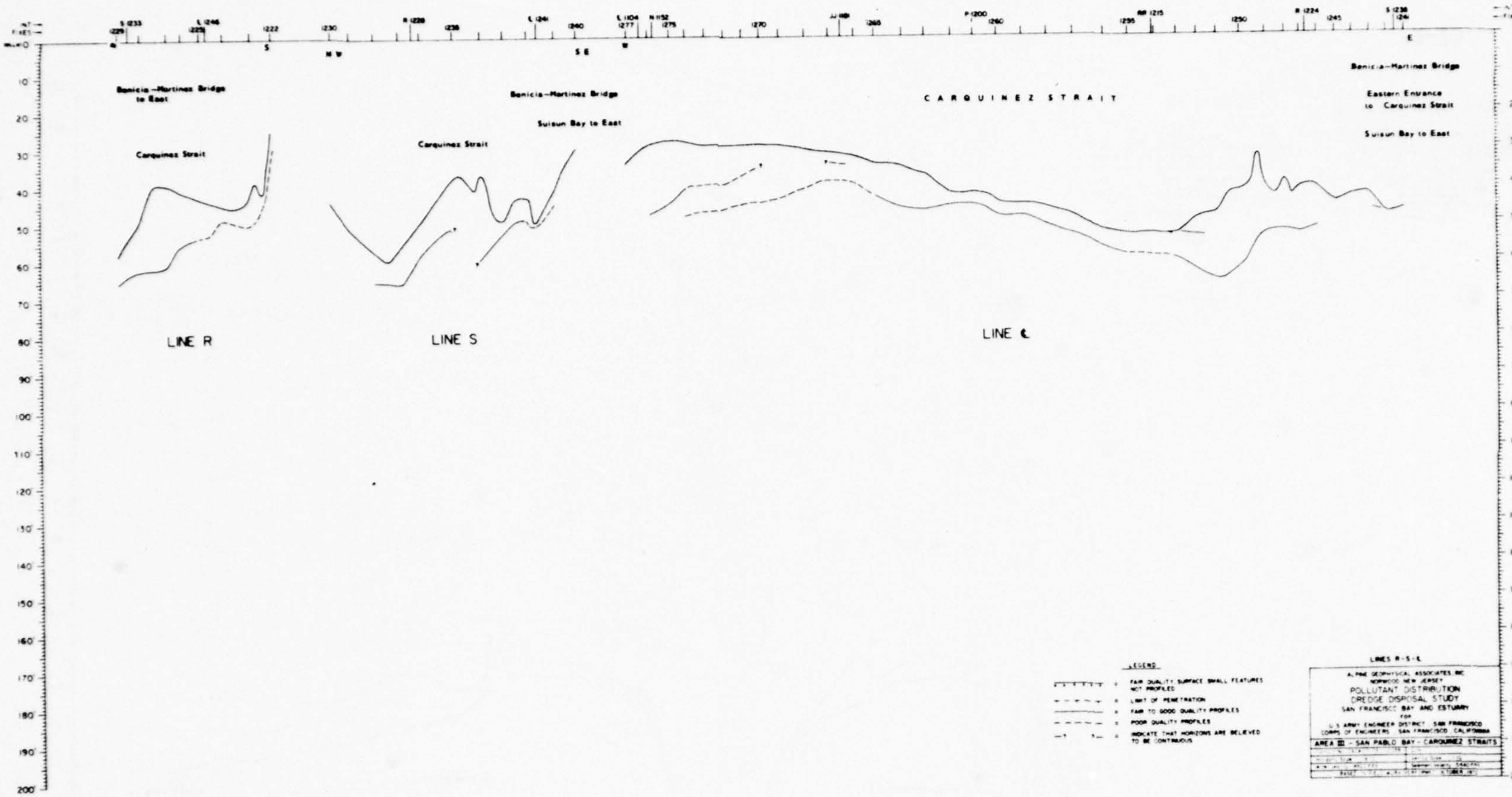

SAN PABLO BAY
Northern Shallows
Southern Shallows
Pinole Shoal Channel
LINE A
LEGEND
CL = CLAYS OF LOW PLASTICITY
SC = CLAYEY SANDS, SAND-CLAY MIXTURES
CL = CLAYS OF LOW TO MEDIUM PLASTICITY, SANDY CLAYS, SILTY CLAYS
SM = SILTY SANDS, SAND-SILT MIXTURES
= LOCATION OF POLLUTION SAMPLES
= FAIR QUALITY, SURFACE, SMALL FEATURES NOT PROFILED
= LIMIT OF PENETRATION
= FAIR TO GOOD QUALITY PROFILES
= POOR QUALITY PROFILES
= INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINE A
ALPINE GEOPHYSICAL ASSOCIATES, INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U S ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS SAN FRANCISCO, CALIFORNIA
AREA III - SAN PABLO BAY - CARQUINEZ STRAITS

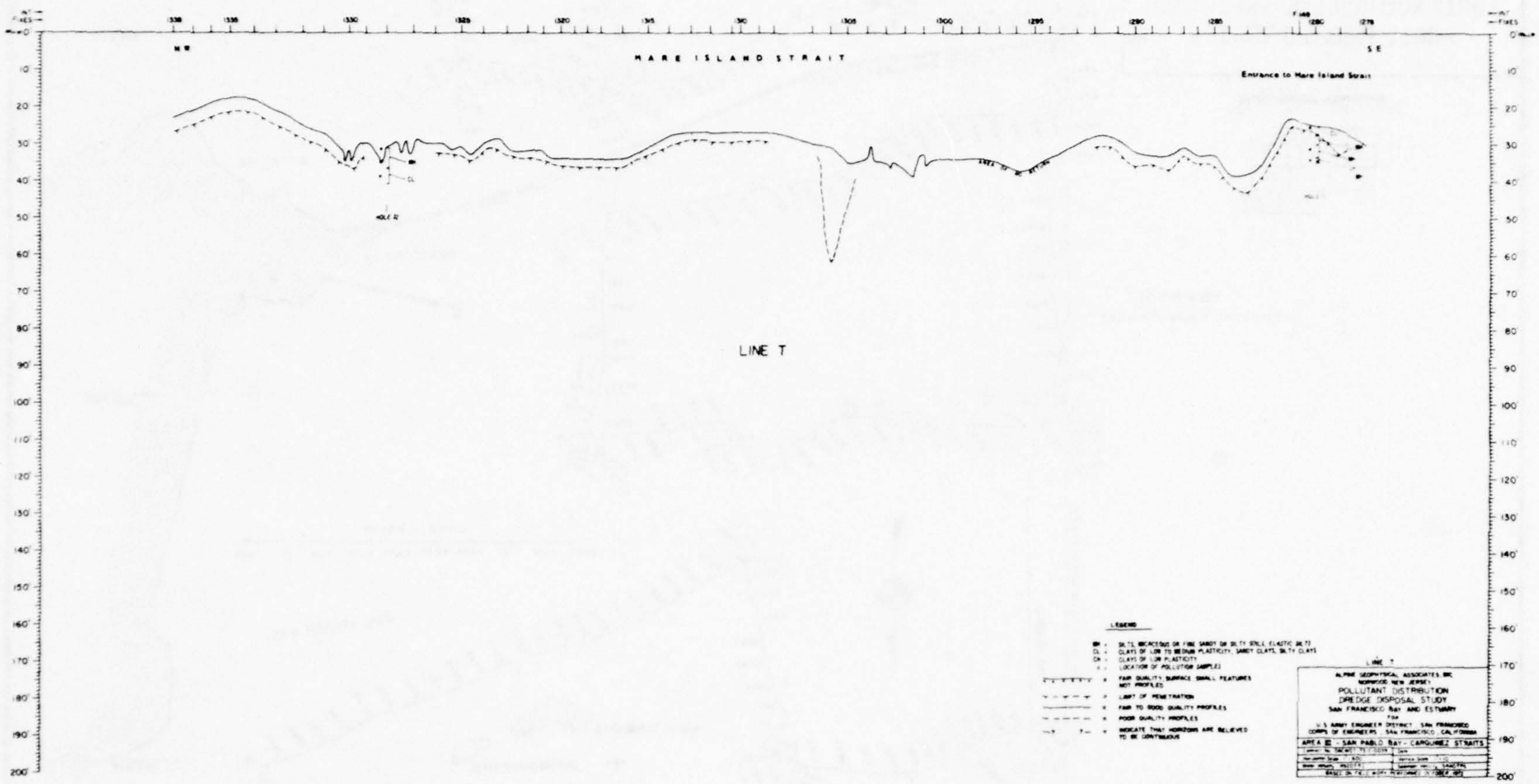

Carquinez Strait
Crockett to South
Dillon Point
Port Costa to South
LINE K
LINE FF
LINE L
LINE GG
LEGEND
LIMIT OF PENETRATION
POOR QUALITY PROFILES
CLAYS OF LOW PLASTICITY
LOCATION OF POLLUTION SAMPLES
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA III - SAN PABLO BAY - CARQUINEZ STRAITS

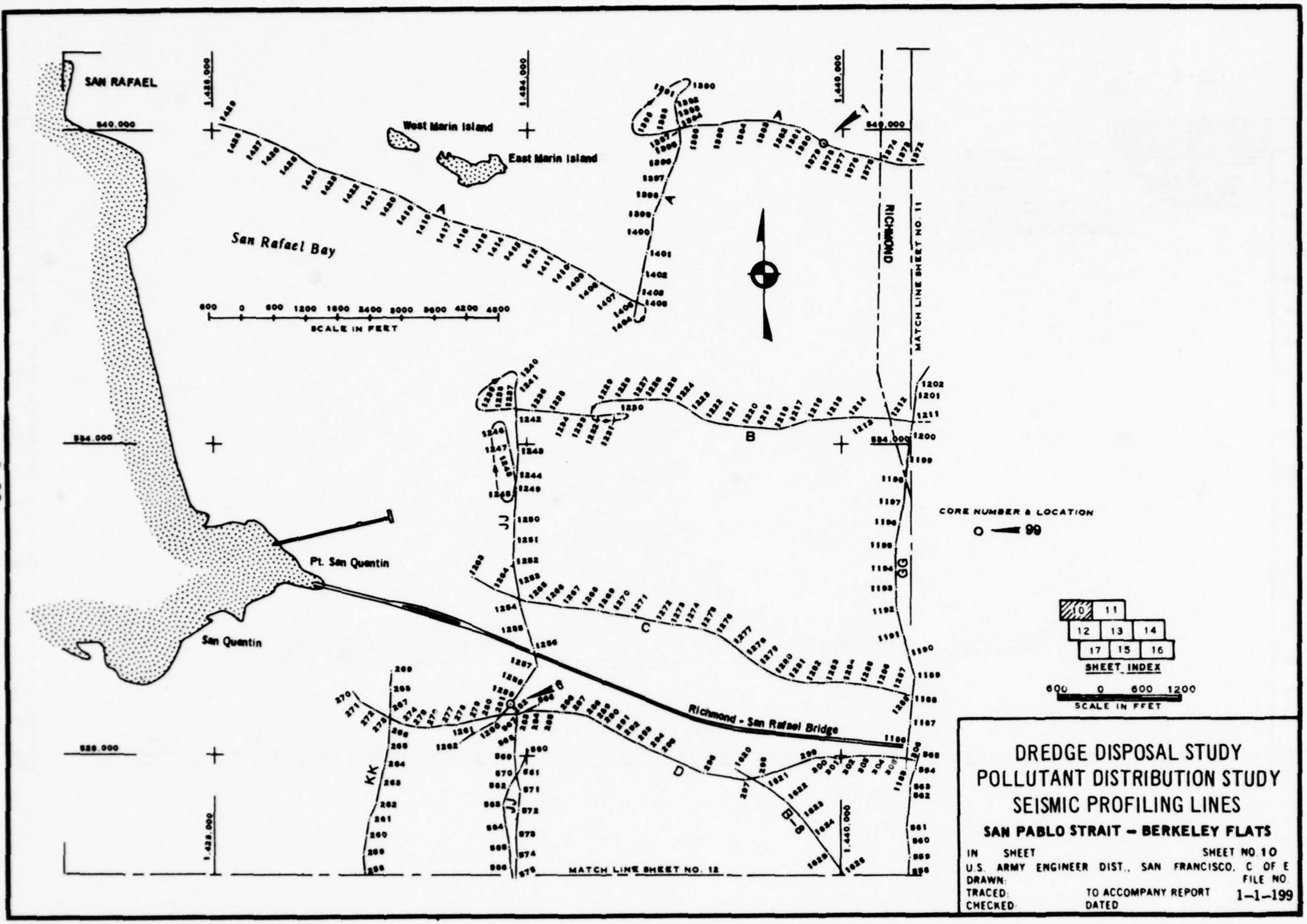

Southampton Bay
Carquinez Point
Carquinez Strait
LINE M
CARQUINEZ STRAIT
HOLE 15
LINE HH
Benicia Point
Carquinez Strait
LINE N
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
CLAYS OF LOW PLASTICITY
LOCATION OF POLLUTION SAMPLES
ALPINE GEOPHYSICAL ASSOCIATES, INC
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
CORPS OF ENGINEERS SAN FRANCISCO, CALIFORNIA
AREA III - SAN PABLO BAY - CARQUINEZ STRAITS


Dillon Point to North
Benicia Point to N E
Carquinez Point to S W
Suisun Bay to East
W
E
Carquinez Bridge
C A R Q U I N E Z S T R A I T
LINE 6
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
ALPINE GEOPHYSICAL ASSOCIATES INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA III - SAN PABLO BAY - CARQUINEZ STRAITS

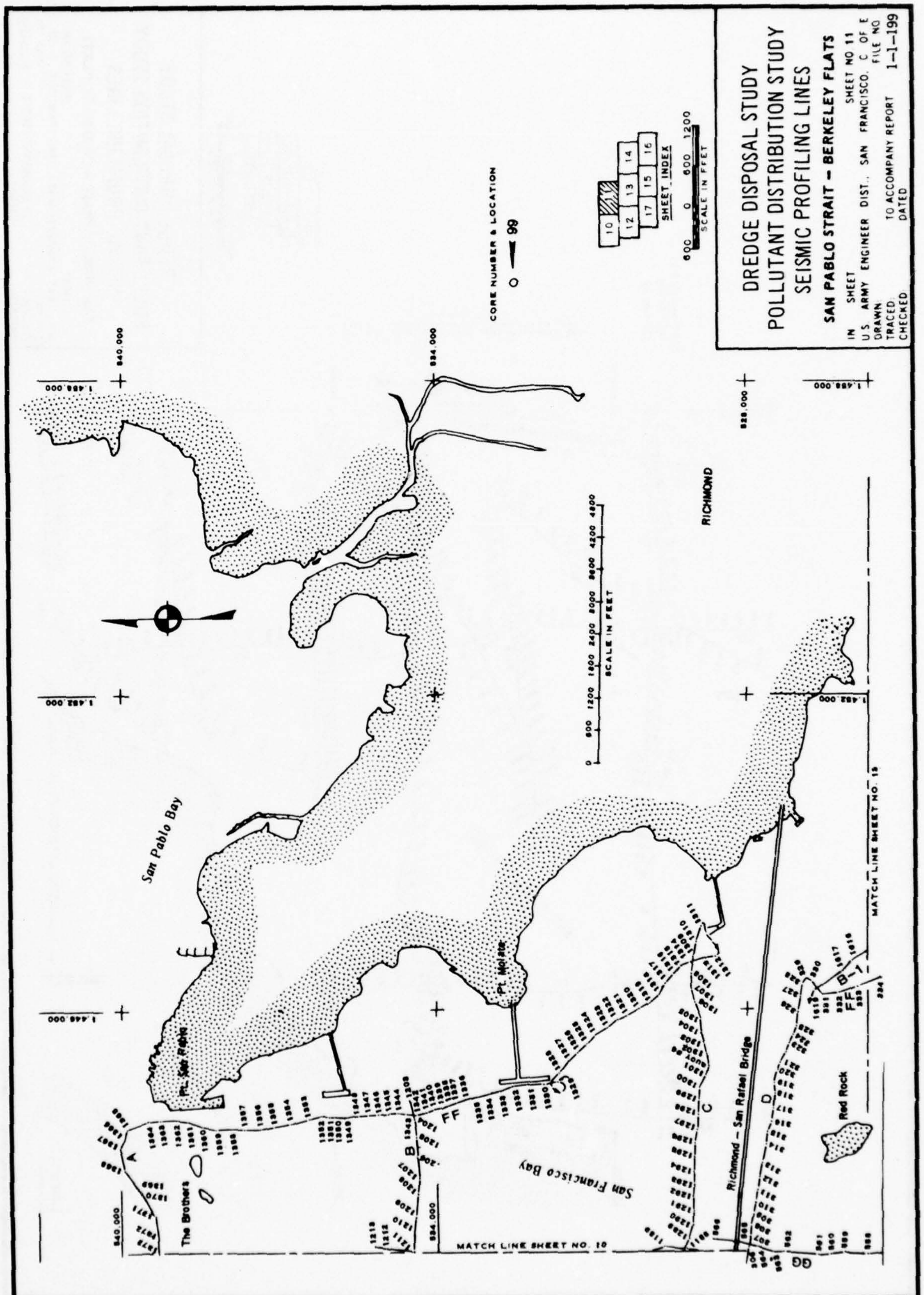

N W
Benicia Point
Carquinez Strait
Martinez
S E
LINE JJ
N
Benicia
Carquinez Strait
Martinez
S
LINE P
N W
Benicia
Carquinez Strait
S E
LINE RR
LEGEND
NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
TO BE CONTINUOUS
NORWOOD NEW JERSEY
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
CORPS OF ENGINEERS SAN FRANCISCO CALIFORNIA
AREA III - SAN PABLO BAY - CARQUINEZ STRAITS

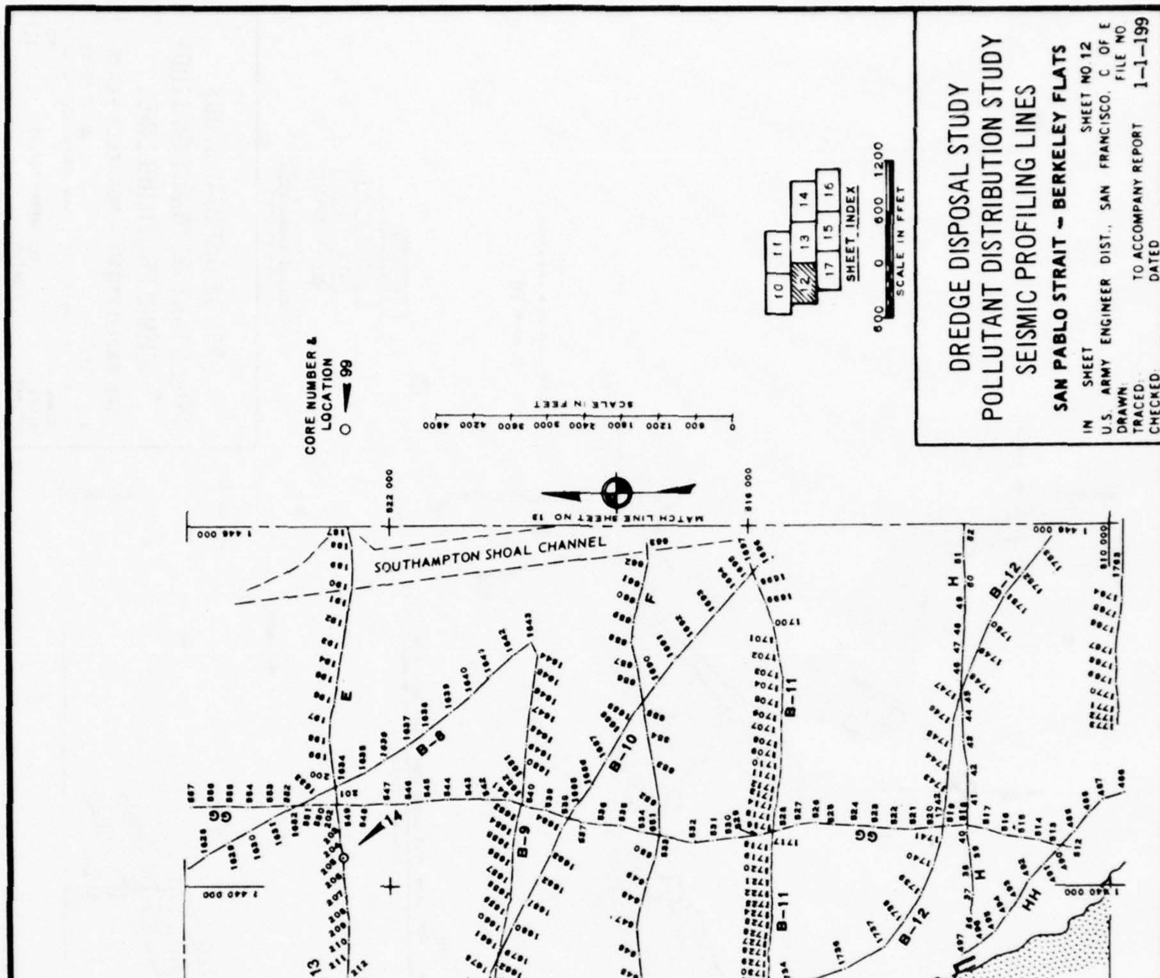

Benicia–Martinez Bridge to East
Carquinez Strait
LINE R
Carquinez Strait
Benicia–Martinez Bridge
Suisun Bay to East
LINE S
CARQUINEZ STRAIT
LINE ℄
Benicia–Martinez Bridge
Eastern Entrance to Carquinez Strait
Suisun Bay to East
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINES R-S-℄
ALPINE GEOPHYSICAL ASSOCIATES, INC.
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA III - SAN PABLO BAY - CARQUINEZ STRAITS

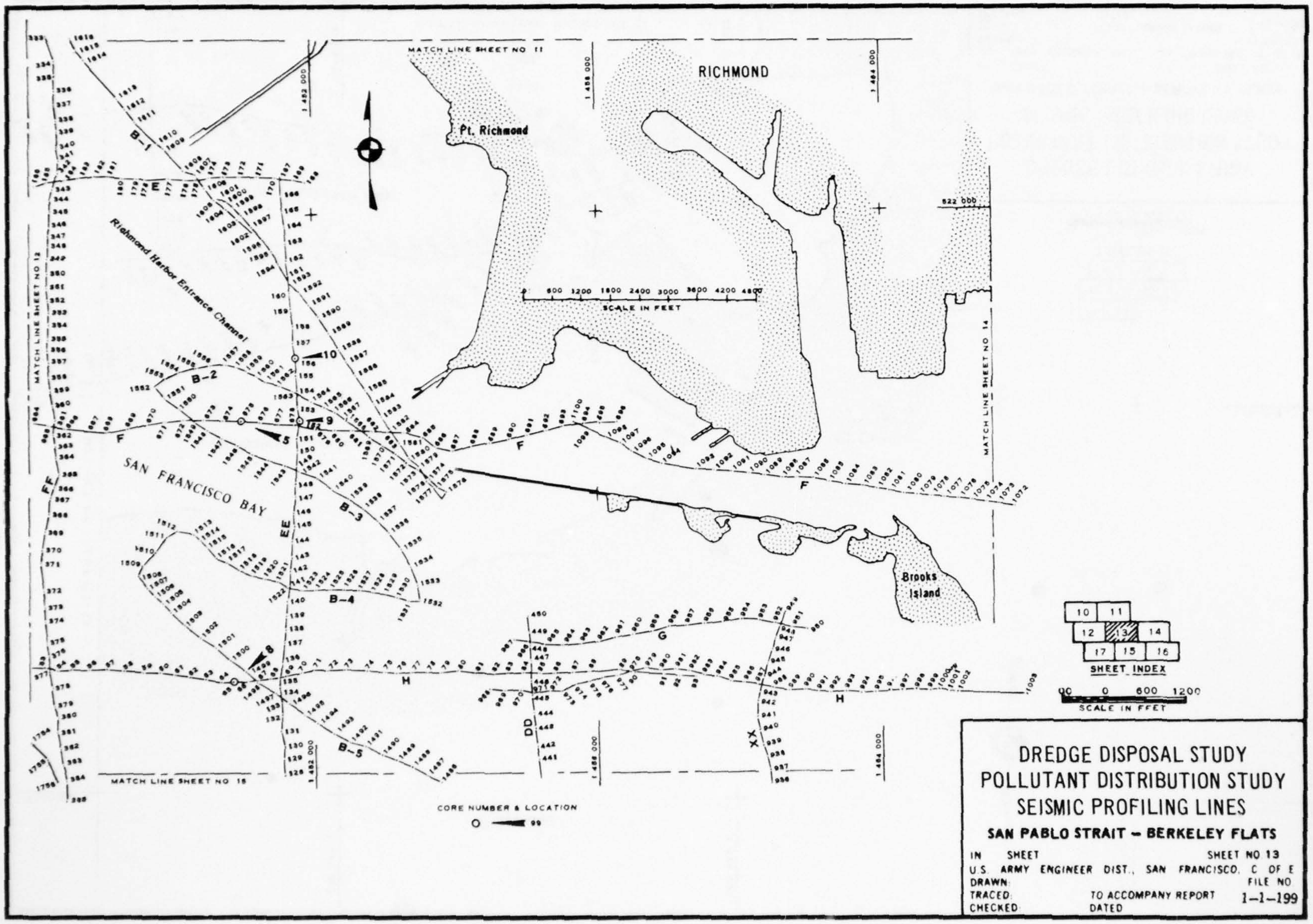

MARE ISLAND STRAIT
Entrance to Mare Island Strait
N W
S E
LINE T
LEGEND
MH = SILTS, MICACEOUS OR FINE SANDY OR SILTY SOILS, ELASTIC SILTS
CL = CLAYS OF LOW TO MEDIUM PLASTICITY, SANDY CLAYS, SILTY CLAYS
CH = CLAYS OF LOW PLASTICITY
LOCATION OF POLLUTION SAMPLES
FAIR QUALITY, SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINE T
ALPINE GEOPHYSICAL ASSOCIATES, INC.
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA III - SAN PABLO BAY - CARQUINEZ STRAITS



SAN RAFAEL
San Rafael Bay
West Marin Island
East Marin Island
Pt. San Quentin
San Quentin
RICHMOND
Richmond - San Rafael Bridge
MATCH LINE SHEET NO. 11
MATCH LINE SHEET NO. 12
SCALE IN FEET
CORE NUMBER & LOCATION
SHEET INDEX
DREDGE DISPOSAL STUDY
POLLUTANT DISTRIBUTION STUDY
SEISMIC PROFILING LINES
SAN PABLO STRAIT – BERKELEY FLATS
IN SHEET
SHEET NO. 10
U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E
DRAWN:
TRACED:
CHECKED:
TO ACCOMPANY REPORT
DATED
FILE NO
1-1-199

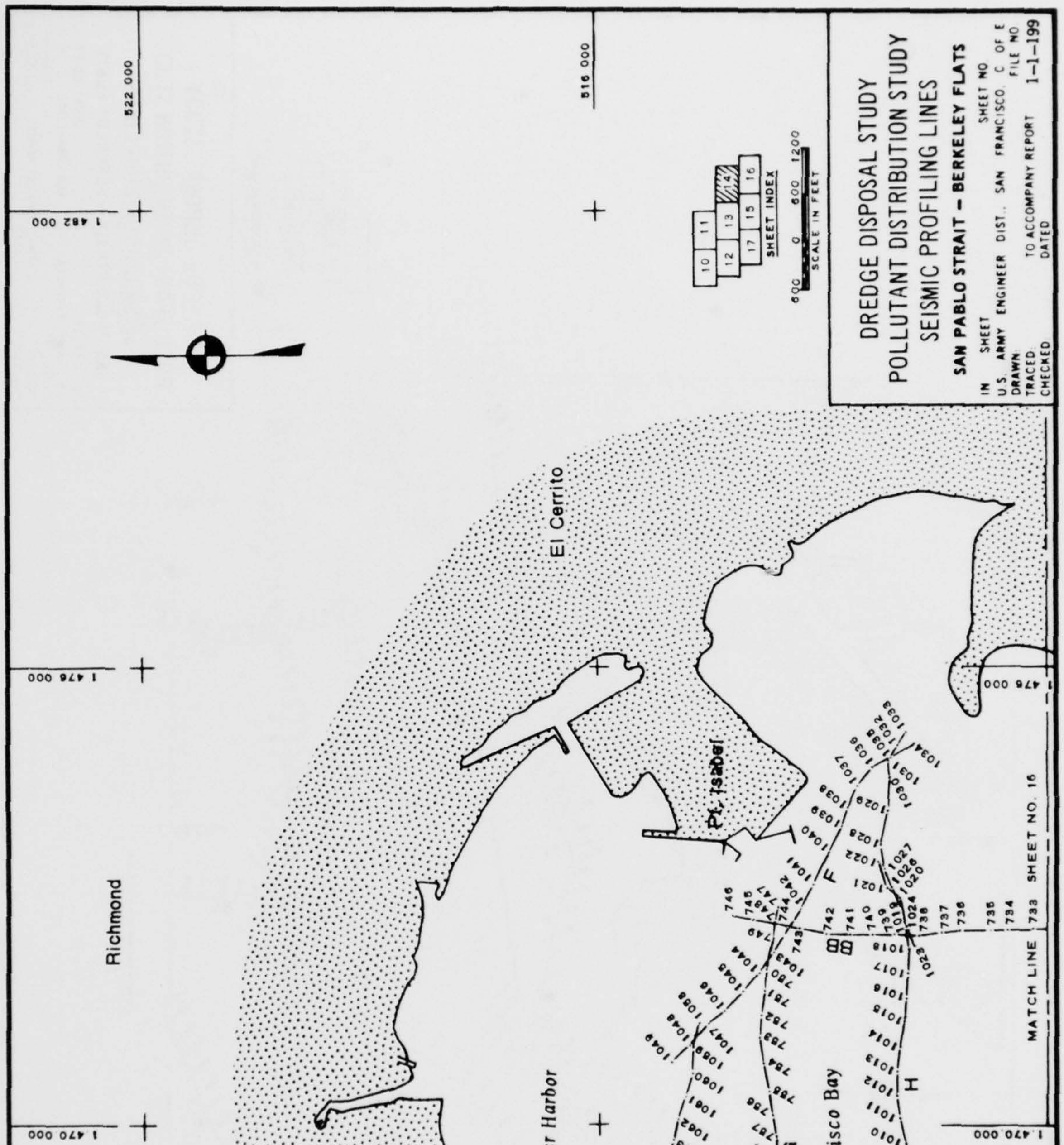

DREDGE DISPOSAL STUDY
POLLUTANT DISTRIBUTION STUDY
SEISMIC PROFILING LINES
SAN PABLO STRAIT – BERKELEY FLATS
IN SHEET SHEET NO 11
U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E
DRAWN FILE NO
TRACED TO ACCOMPANY REPORT 1-1-199
CHECKED DATED
SHEET INDEX
10 11 12 13 14 15 16 17
600 0 600 1200
SCALE IN FEET
CORE NUMBER & LOCATION
99
0 600 1200 1800 2400 3000 3600 4200 4800
SCALE IN FEET
San Pablo Bay
San Francisco Bay
RICHMOND
Pt. San Pablo
Pt. Molate
The Brothers
Red Rock
Richmond – San Rafael Bridge
MATCH LINE SHEET NO. 10
MATCH LINE SHEET NO. 12
840,000
834,000
828,000
1,488,000
1,482,000
1,446,000
A
B
C
D
FF
GG

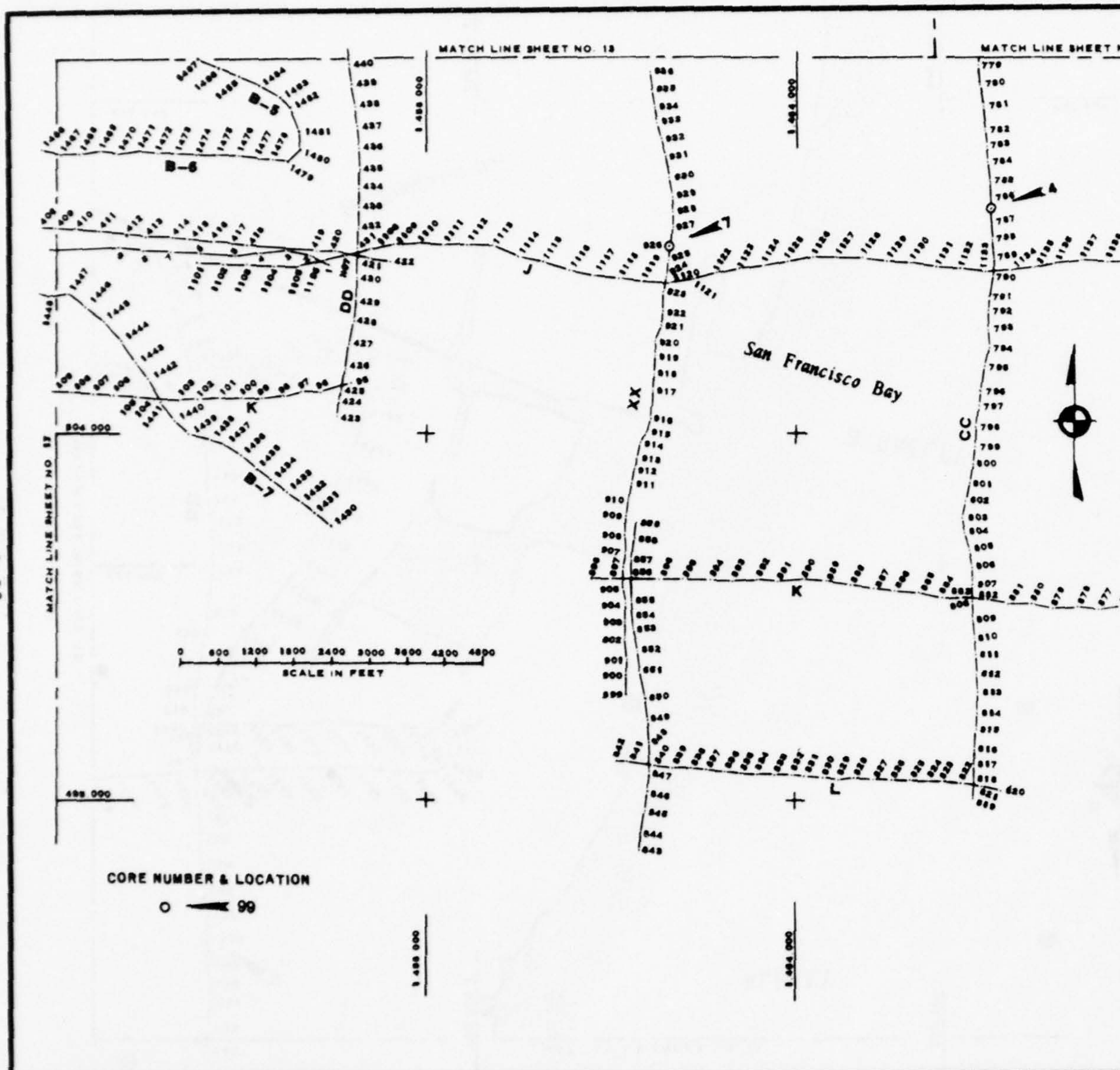

DREDGE DISPOSAL STUDY
POLLUTANT DISTRIBUTION STUDY
SEISMIC PROFILING LINES
SAN PABLO STRAIT – BERKELEY FLATS
IN SHEET SHEET NO 12
U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E
DRAWN: FILE NO
TRACED: TO ACCOMPANY REPORT 1-1-199
CHECKED: DATED
SHEET INDEX
SCALE IN FEET
CORE NUMBER & LOCATION
SOUTHAMPTON SHOAL CHANNEL
SAN FRANCISCO BAY
TIBURON PENINSULA
MATCH LINE SHEET NO 10
MATCH LINE SHEET NO 13
MATCH LINE SHEET NO 17



DREDGE DISPOSAL STUDY
POLLUTANT DISTRIBUTION STUDY
SEISMIC PROFILING LINES
SAN PABLO STRAIT – BERKELEY FLATS

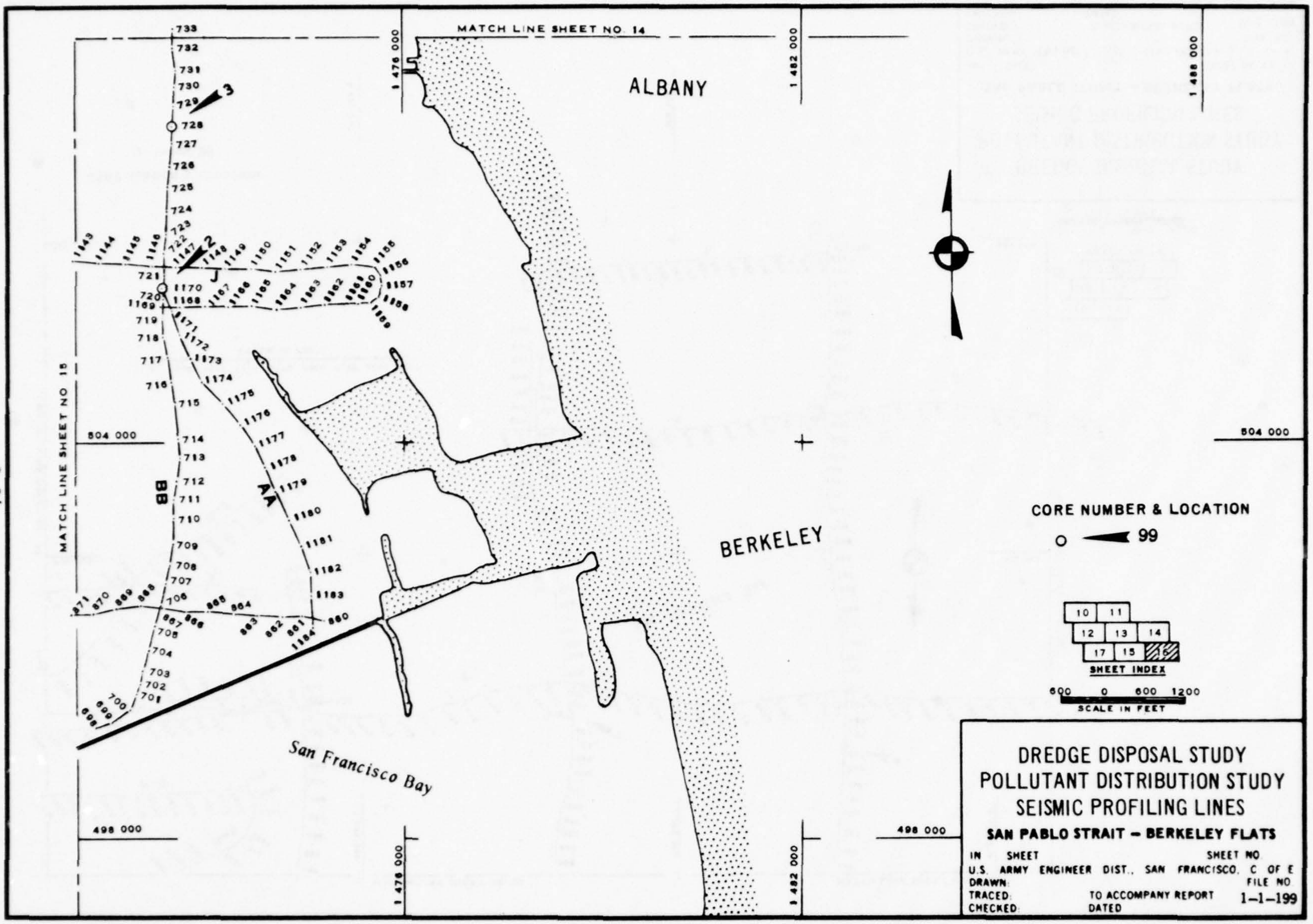
IN SHEET SHEET NO 13
U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E
DRAWN: FILE NO
TRACED: TO ACCOMPANY REPORT 1-1-199
CHECKED: DATED


DREDGE DISPOSAL STUDY
POLLUTANT DISTRIBUTION STUDY
SEISMIC PROFILING LINES
SAN PABLO STRAIT – BERKELEY FLATS
IN SHEET SHEET NO
U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C. OF E
DRAWN: TRACED: CHECKED:
TO ACCOMPANY REPORT DATED
FILE NO 1-1-199
SHEET INDEX
SCALE IN FEET
Richmond
El Cerrito
Pt. Isabel
Richmond Inner Harbor
San Francisco Bay
MATCH LINE SHEET NO. 16
MATCH LINE SHEET NO. 13
522 000
516 000
1 482 000
1 476 000
1 470 000



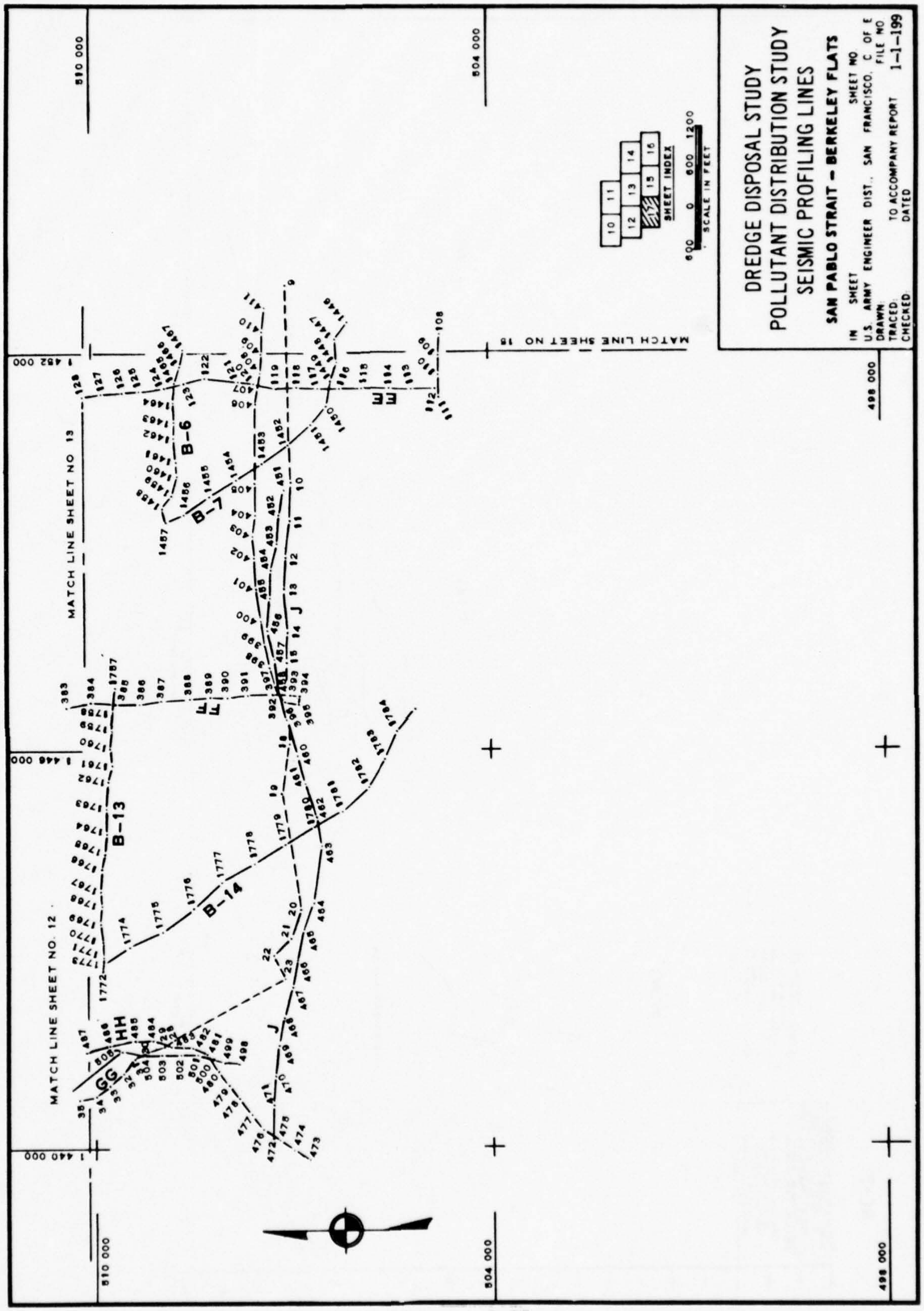
DREDGE DISPOSAL STUDY
POLLUTANT DISTRIBUTION STUDY
SEISMIC PROFILING LINES
SAN PABLO STRAIT – BERKELEY FLATS

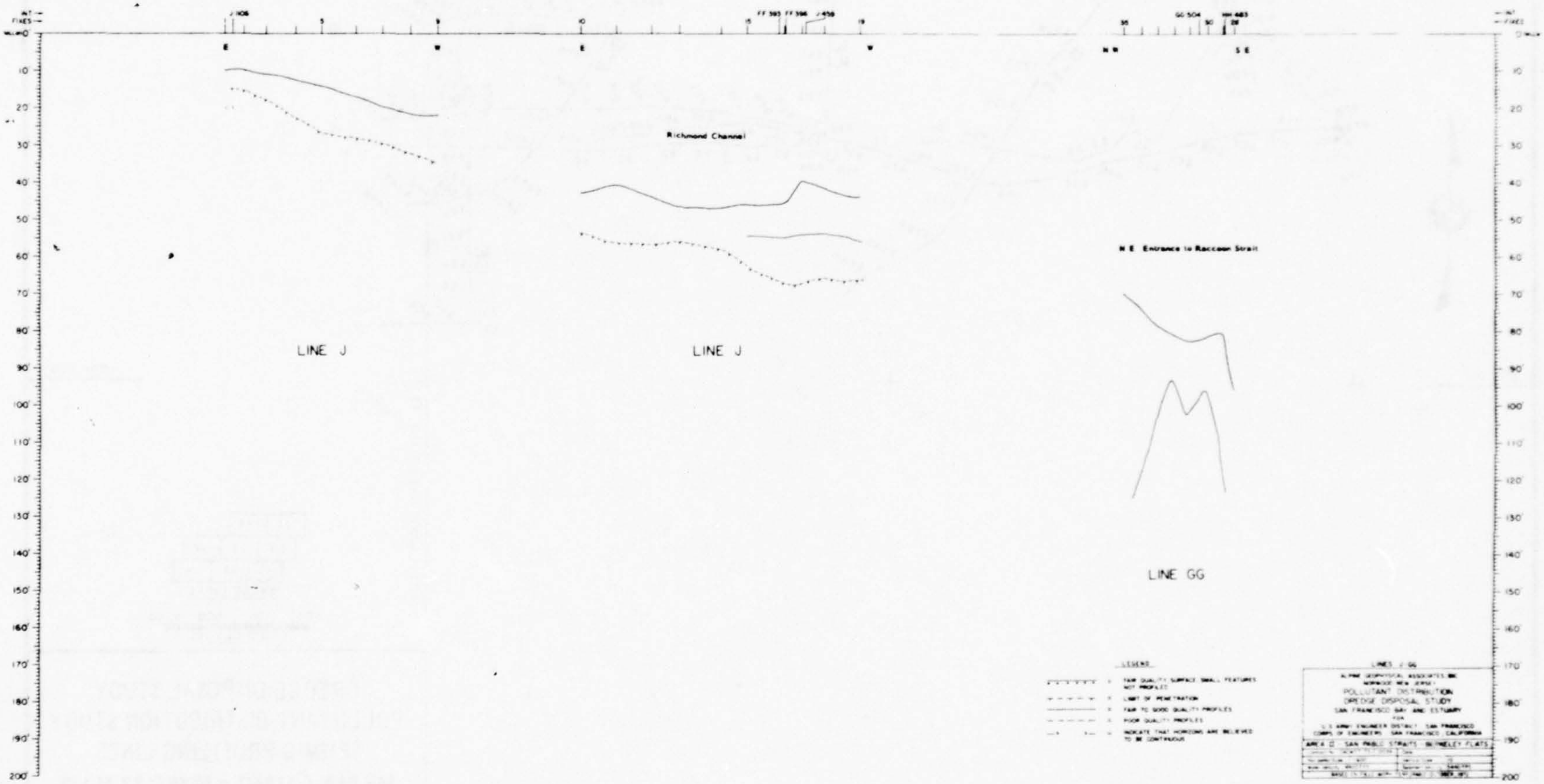
IN SHEET — SHEET NO 15
U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E
DRAWN — FILE NO
TRACED — TO ACCOMPANY REPORT — 1-1-199
CHECKED — DATED



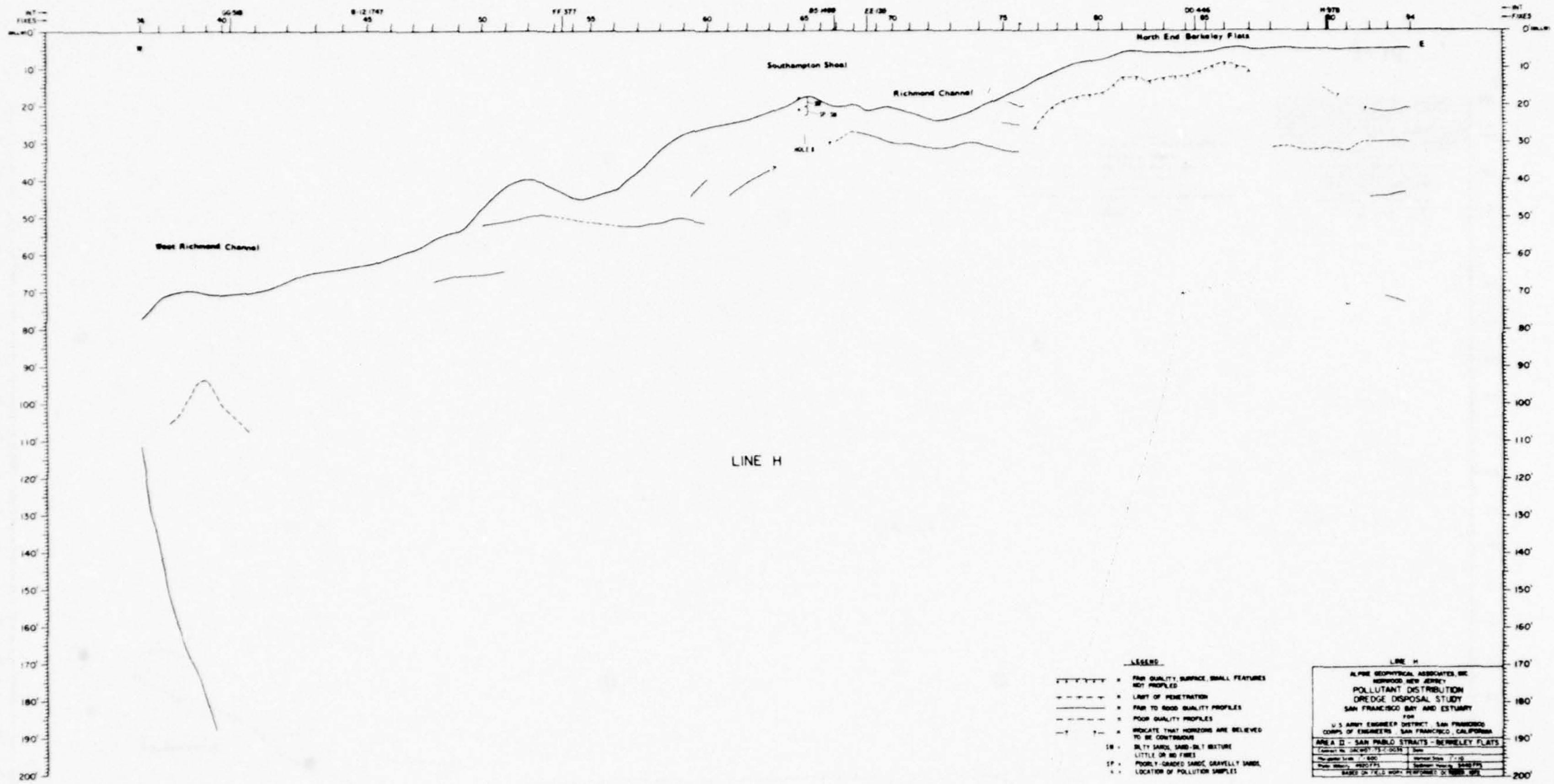
DREDGE DISPOSAL STUDY
POLLUTANT DISTRIBUTION STUDY
SEISMIC PROFILING LINES
SAN PABLO STRAIT – BERKELEY FLATS

IN SHEET SHEET NO
U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E
DRAWN: FILE NO
TRACED: TO ACCOMPANY REPORT 1-1-199
CHECKED: DATED

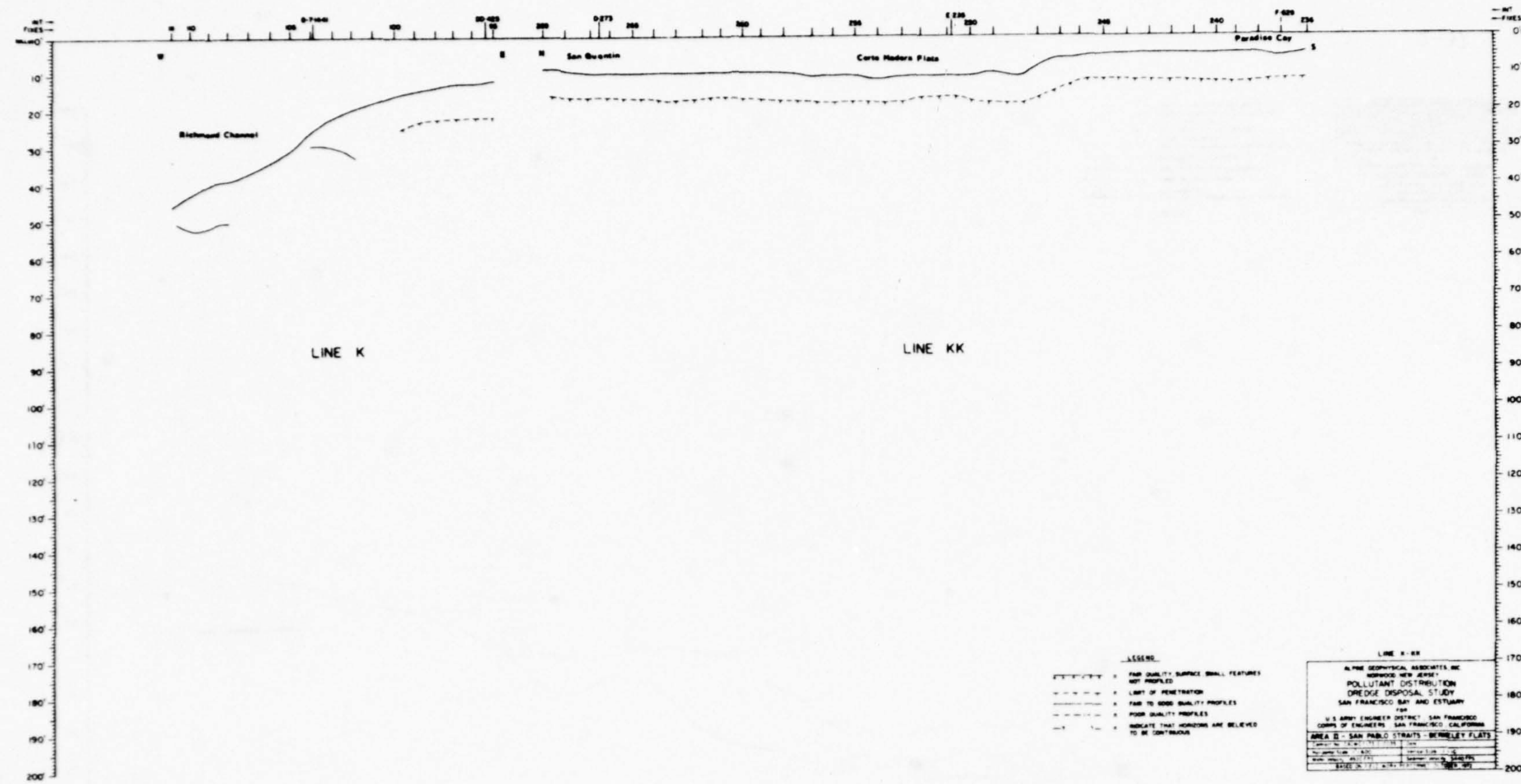

DREDGE DISPOSAL STUDY
POLLUTANT DISTRIBUTION STUDY
SEISMIC PROFILING LINES
SAN PABLO STRAIT – BERKELEY FLATS
IN SHEET SHEET NO
U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C. OF E
DRAWN: FILE NO
TRACED: TO ACCOMPANY REPORT 1-1-199
CHECKED: DATED
SHEET INDEX
SCALE IN FEET
MATCH LINE SHEET NO. 12
MATCH LINE SHEET NO 13
MATCH LINE SHEET NO 15
510 000
504 000
498 000
1 440 000
1 446 000
1 452 000
B-6
B-7
B-13
B-14
GG
HH
J
EE
FF

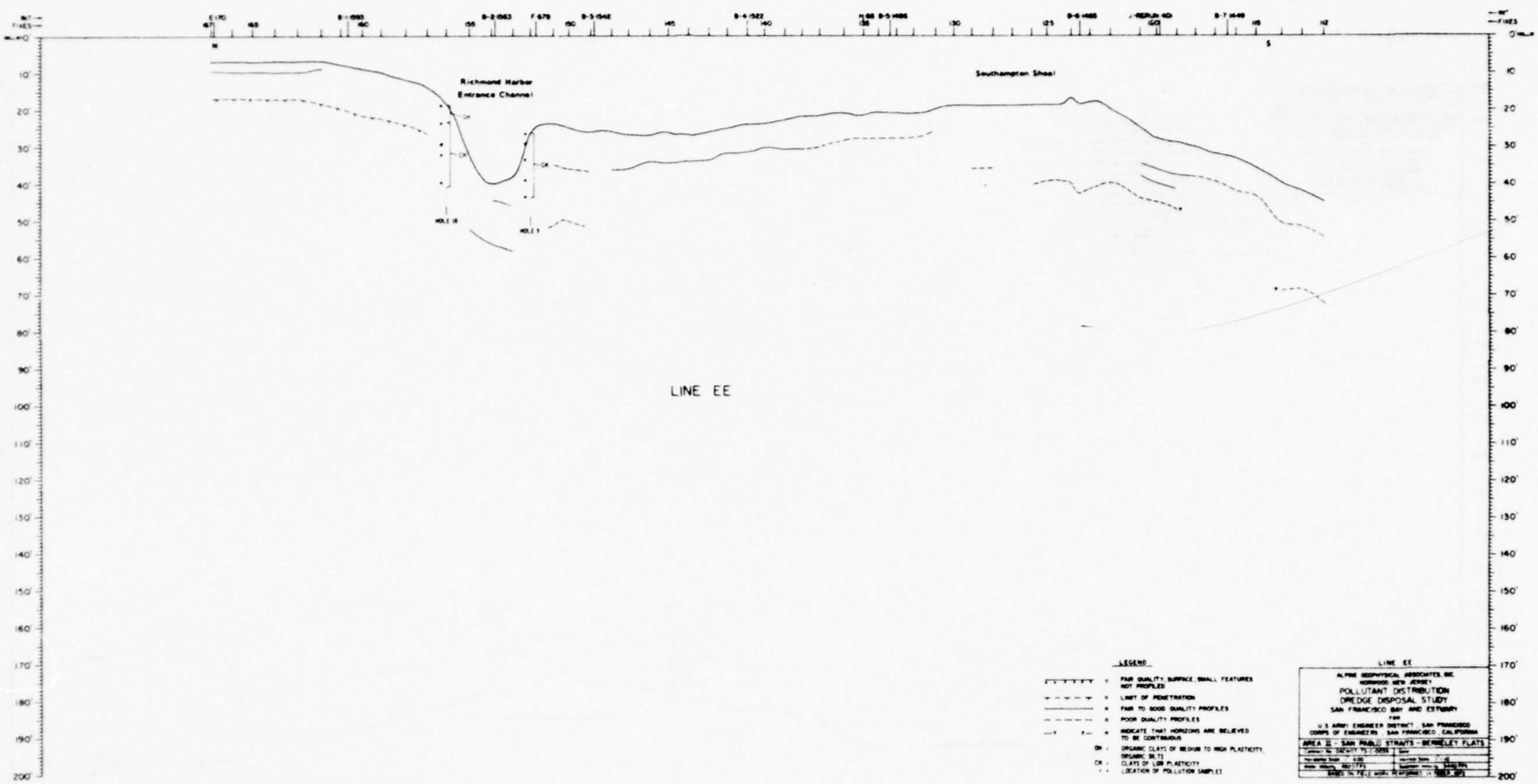


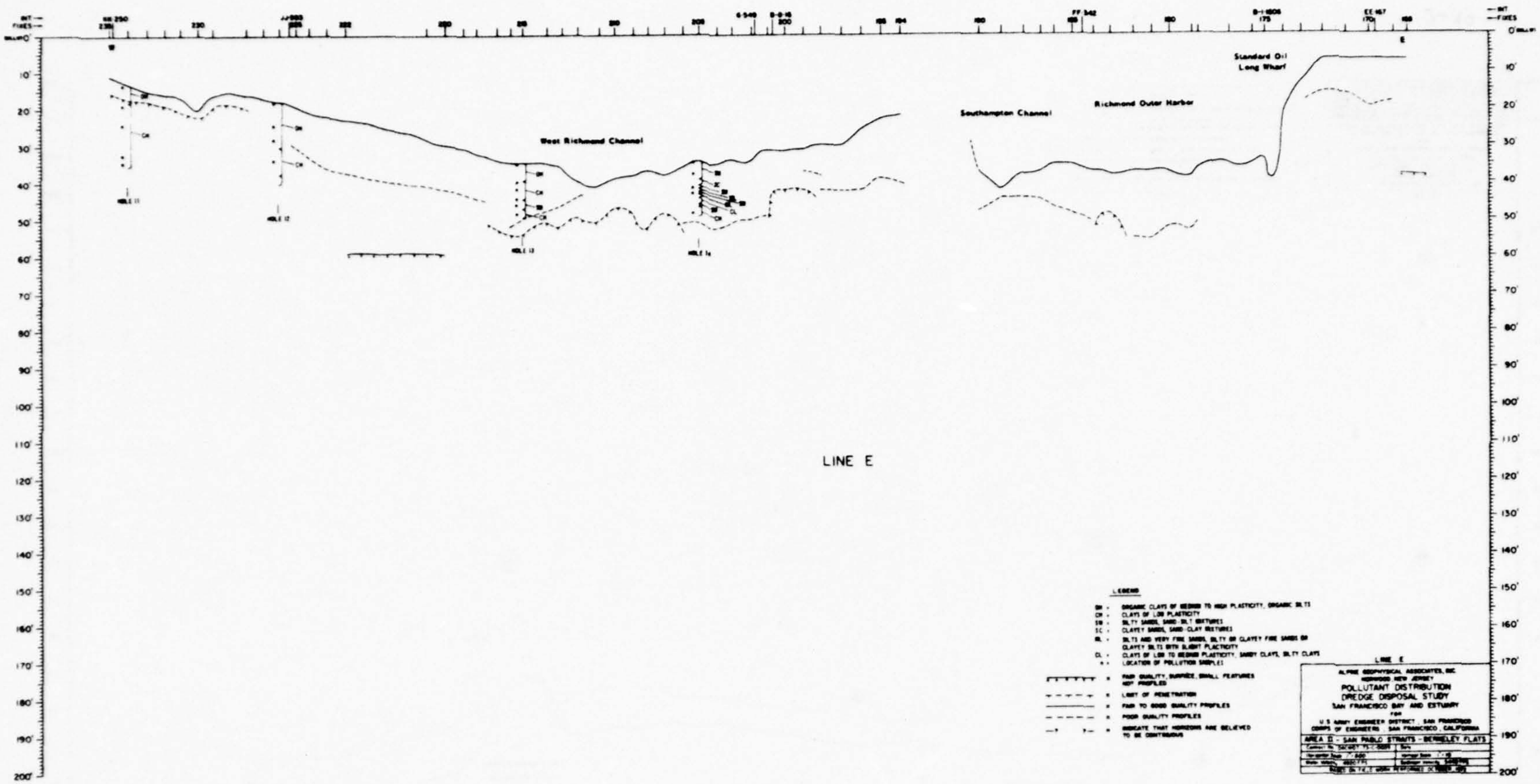
Richmond Channel
N E Entrance to Raccoon Strait
LINE J
LINE J
LINE GG
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINES J GG
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U S ARMY ENGINEER DISTRICT SAN FRANCISCO
CORPS OF ENGINEERS SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS

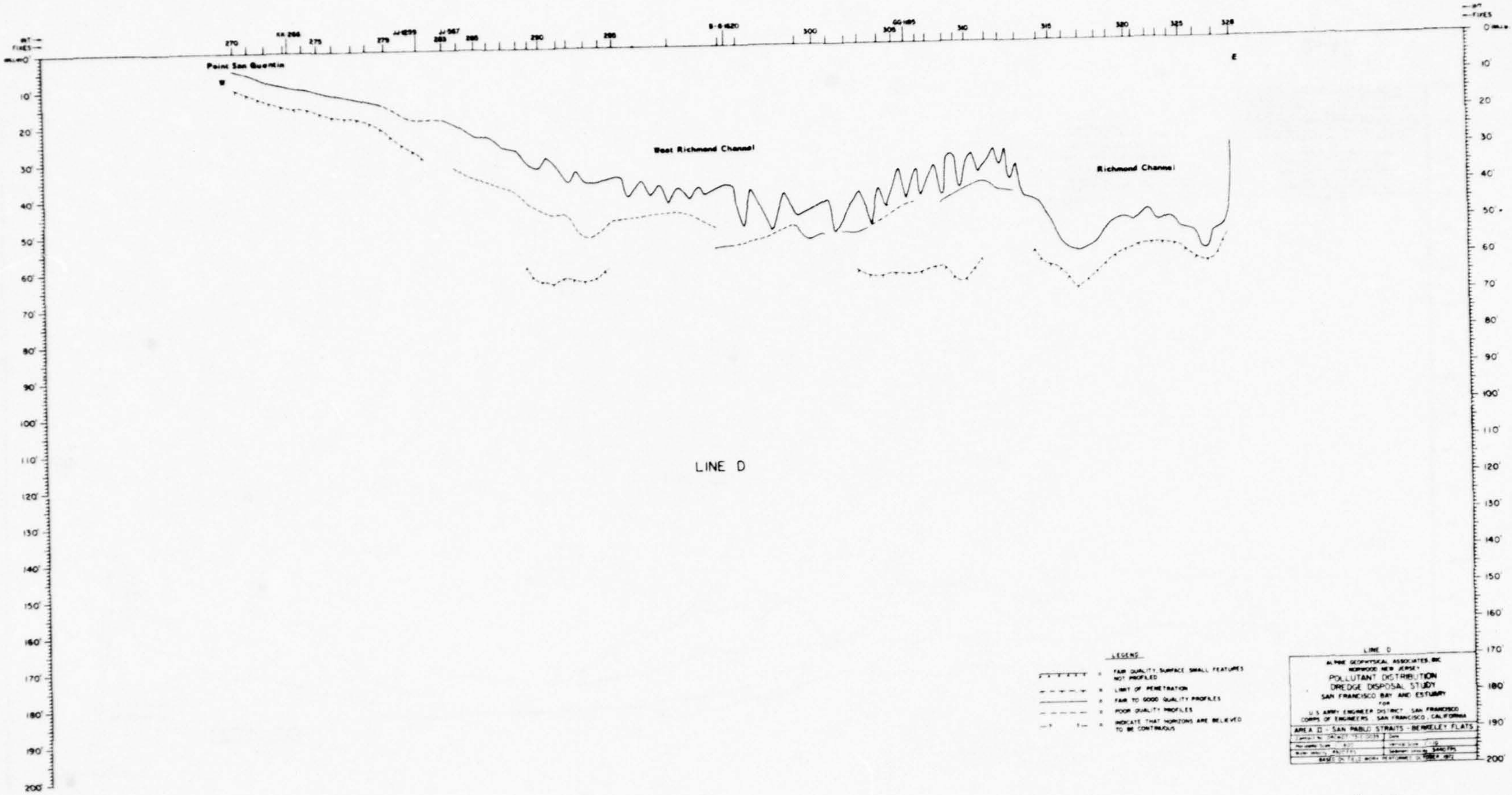


North End Berkeley Flats
Southampton Shoal
Richmond Channel
West Richmond Channel
LINE H
LEGEND
FAIR QUALITY SURFACE, SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
SM - SILTY SANDS, SAND-SILT MIXTURE LITTLE OR NO FINES
SP - POORLY-GRADED SANDS, GRAVELLY SANDS,
LOCATION OF POLLUTION SAMPLES
LINE H
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA D - SAN PABLO STRAITS - BERKELEY FLATS

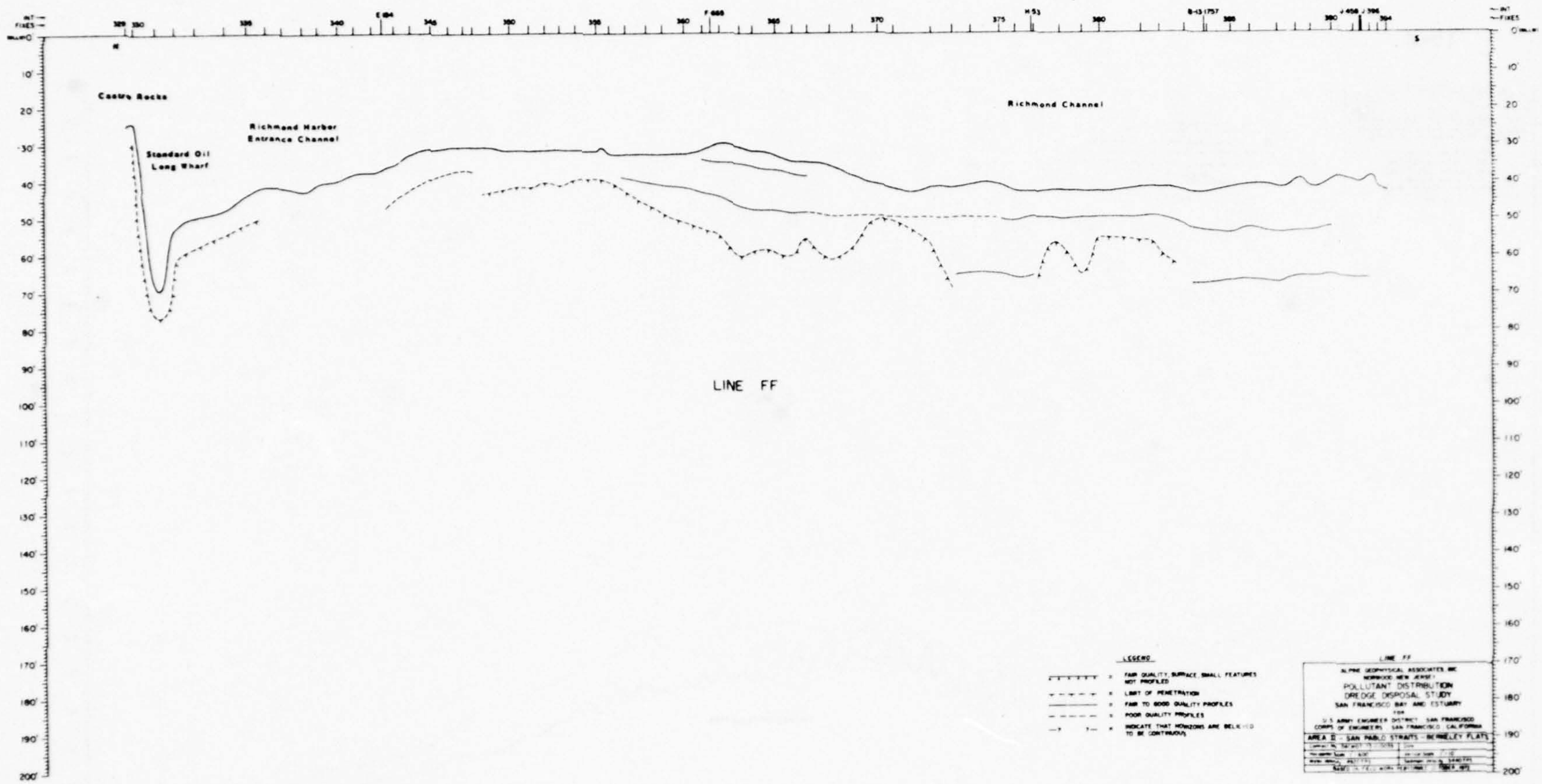

Richmond Channel
San Quentin
Corte Madera Flats
Paradise Cay
LINE K
LINE KK
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINE K-KK
ALPINE GEOPHYSICAL ASSOCIATES, INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
for
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS


Richmond Harbor
Entrance Channel
Southampton Shoal
HOLE 18
HOLE 1
LINE EE
LEGEND
FAIR QUALITY SURFACE, SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
OH : ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
CH : CLAYS OF LOW PLASTICITY
LOCATION OF POLLUTION SAMPLES
LINE EE
ALPINE GEOPHYSICAL ASSOCIATES, INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS

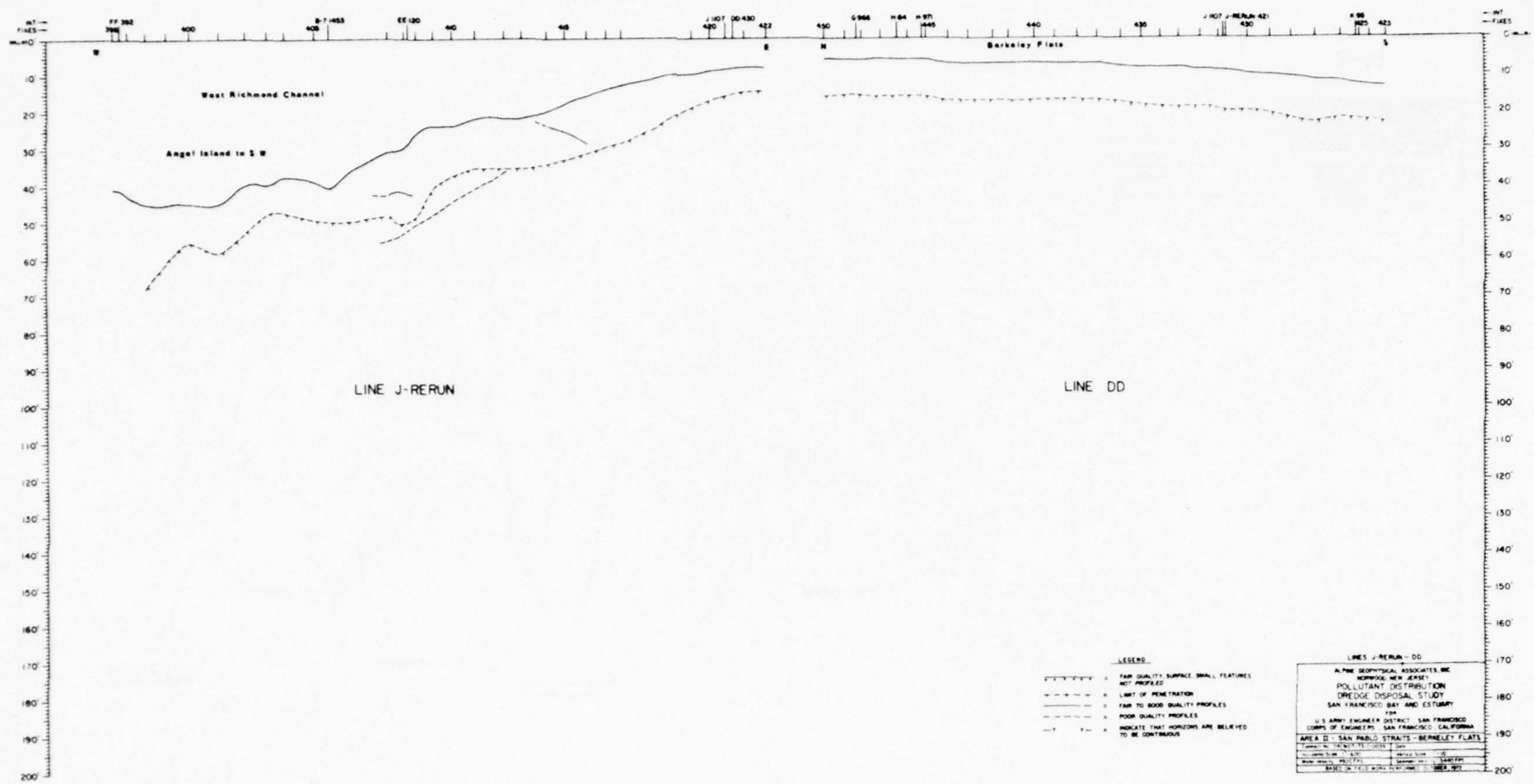

West Richmond Channel
Southampton Channel
Richmond Outer Harbor
Standard Oil
Long Wharf
HOLE 11
HOLE 12
HOLE 13
HOLE 14
LINE E
LEGEND
LINE E
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA D - SAN PABLO STRAITS - BERKELEY FLATS

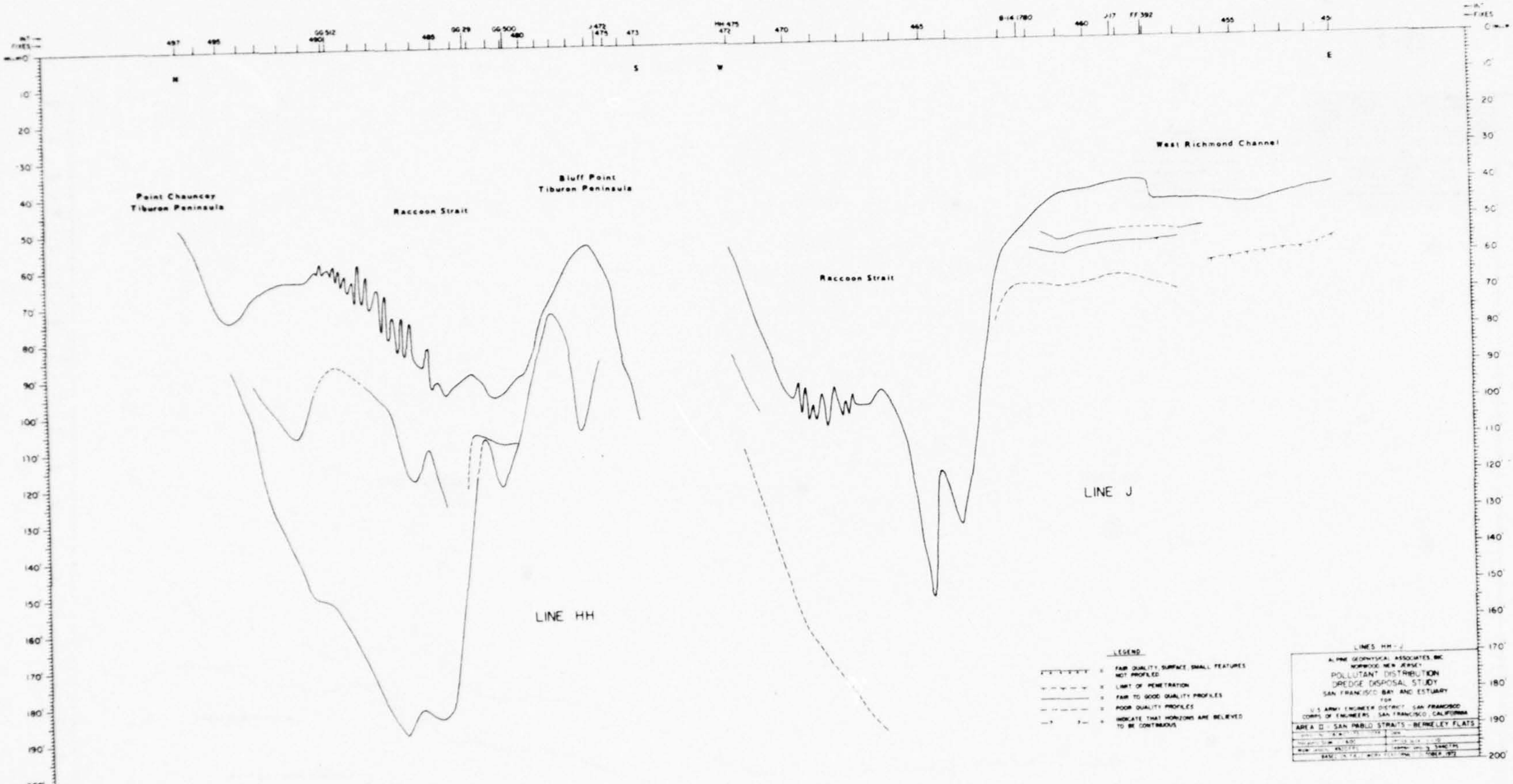


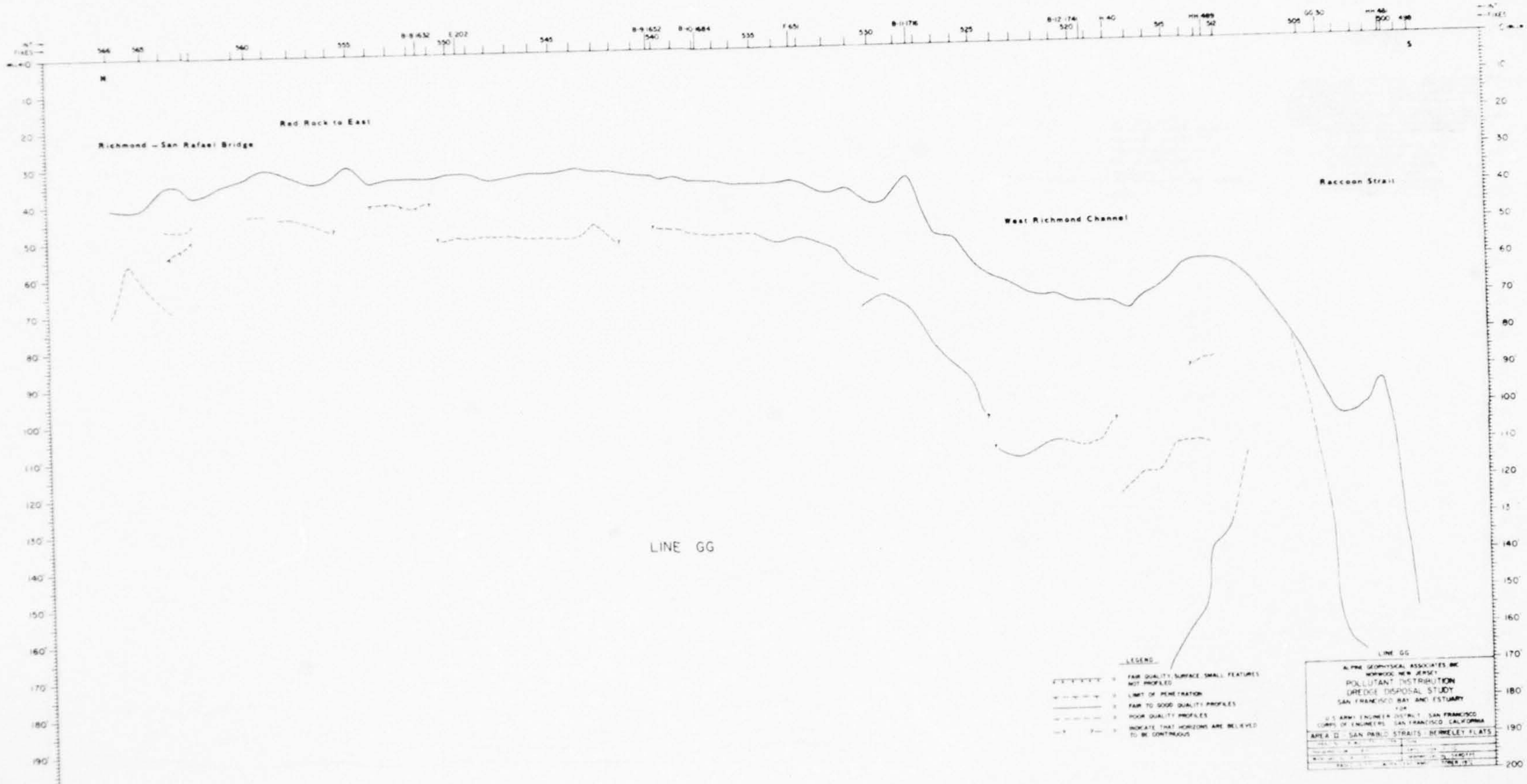
Point San Quentin
W
E
270
275
280
285
290
295
300
305
310
315
320
325
328
West Richmond Channel
Richmond Channel
LINE D
LEGEND
FAIR QUALITY, SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINE D
ALPINE GEOPHYSICAL ASSOCIATES, INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS

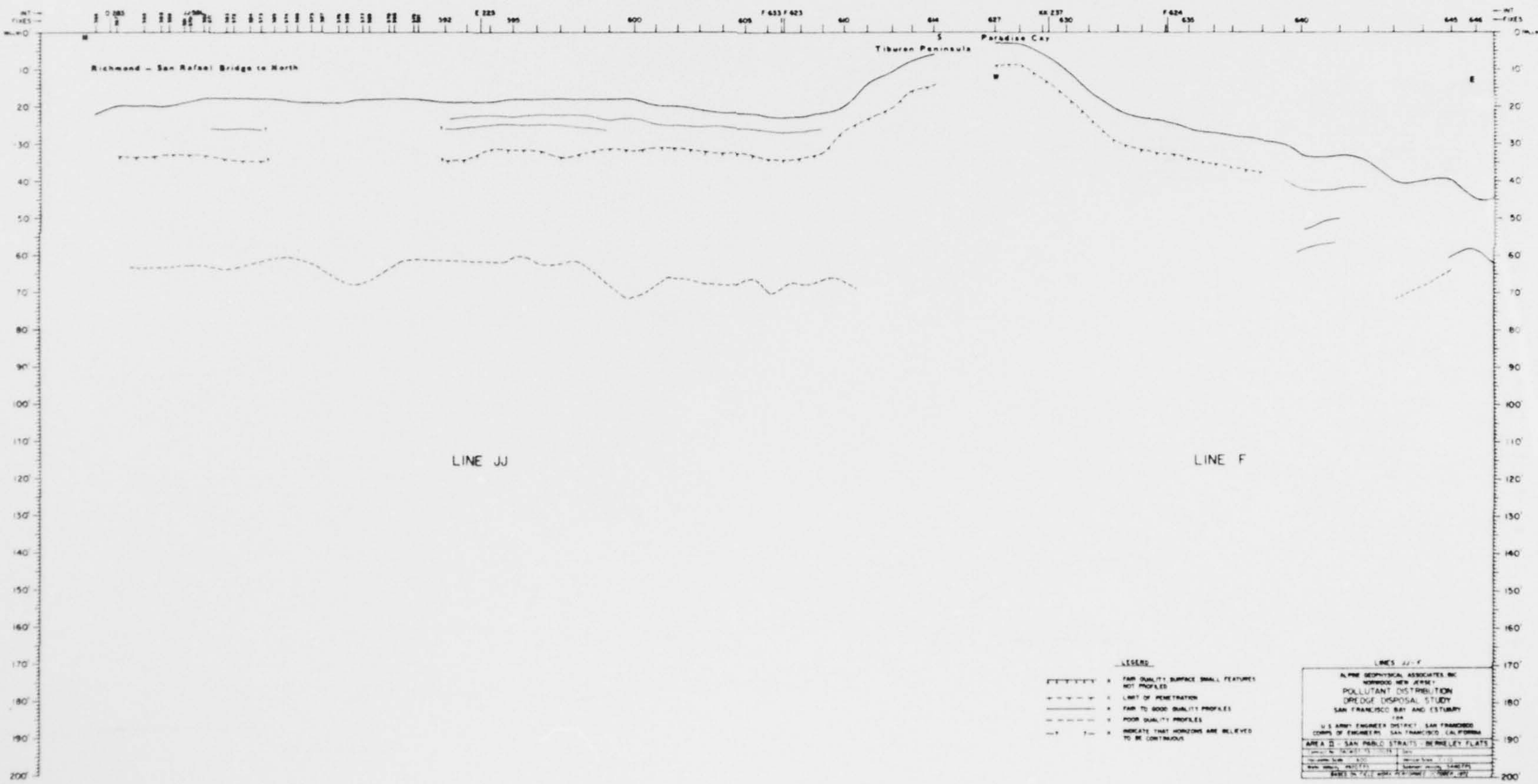


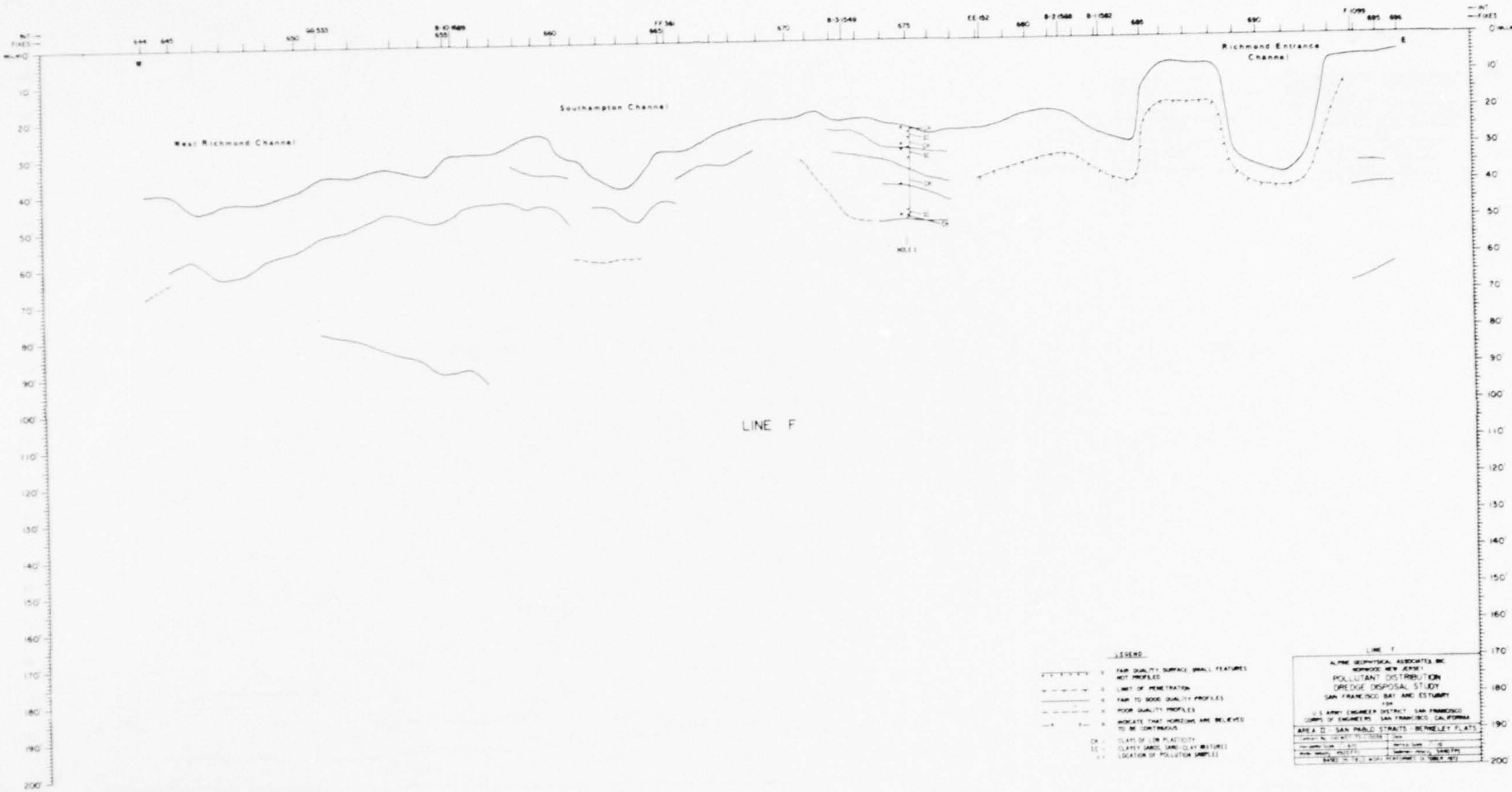
Castro Rocks
Standard Oil Long Wharf
Richmond Harbor Entrance Channel
Richmond Channel
LINE FF
LEGEND
= FAIR QUALITY, SURFACE, SMALL FEATURES NOT PROFILED
= LIMIT OF PENETRATION
= FAIR TO GOOD QUALITY PROFILES
= POOR QUALITY PROFILES
= INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINE FF
ALPINE GEOPHYSICAL ASSOCIATES INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS

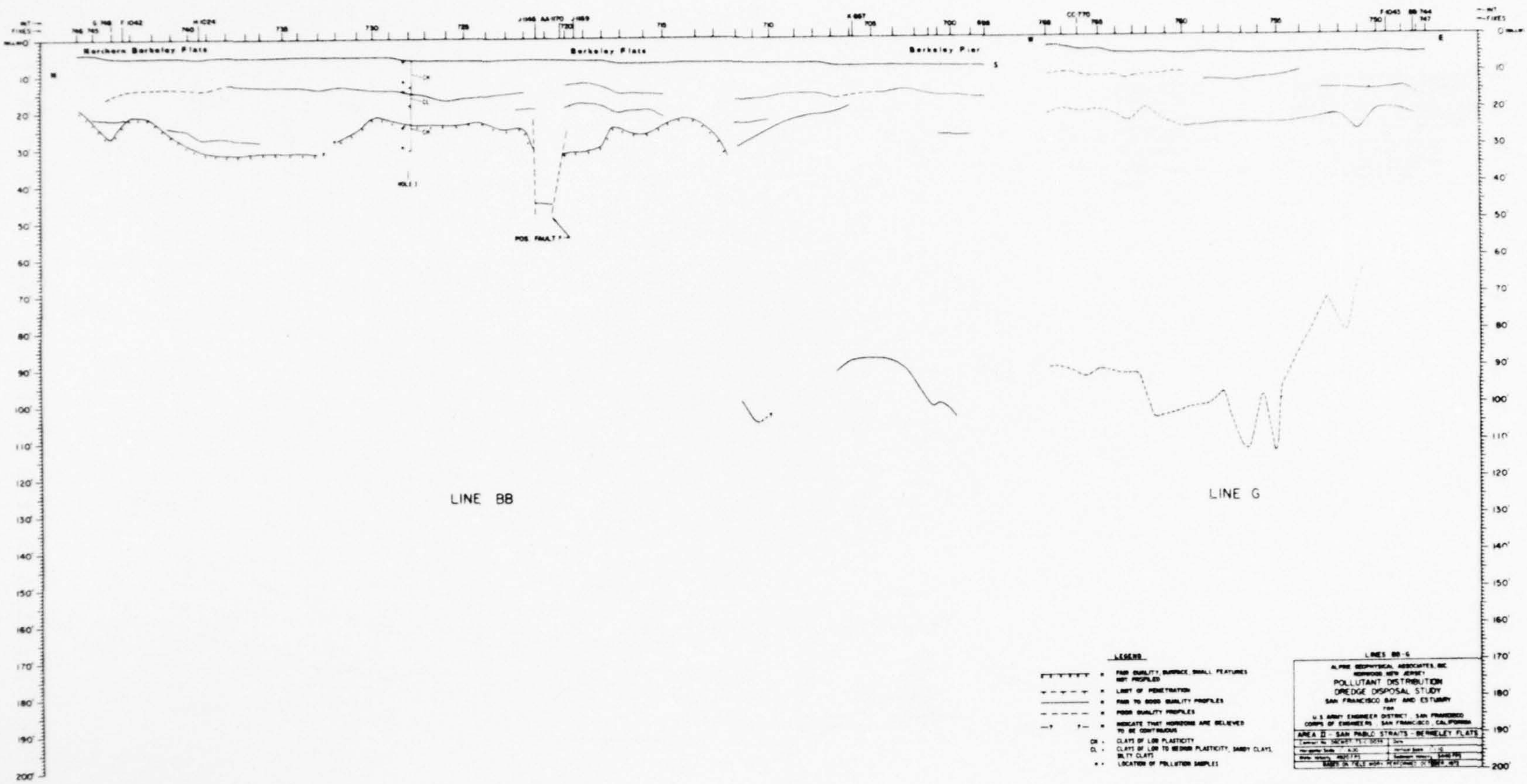

West Richmond Channel
Angel Island to S W
Berkeley Flats
LINE J-RERUN
LINE DD
LEGEND
FAIR QUALITY SURFACE, SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINES J-RERUN - DD
ALPINE GEOPHYSICAL ASSOCIATES, INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS

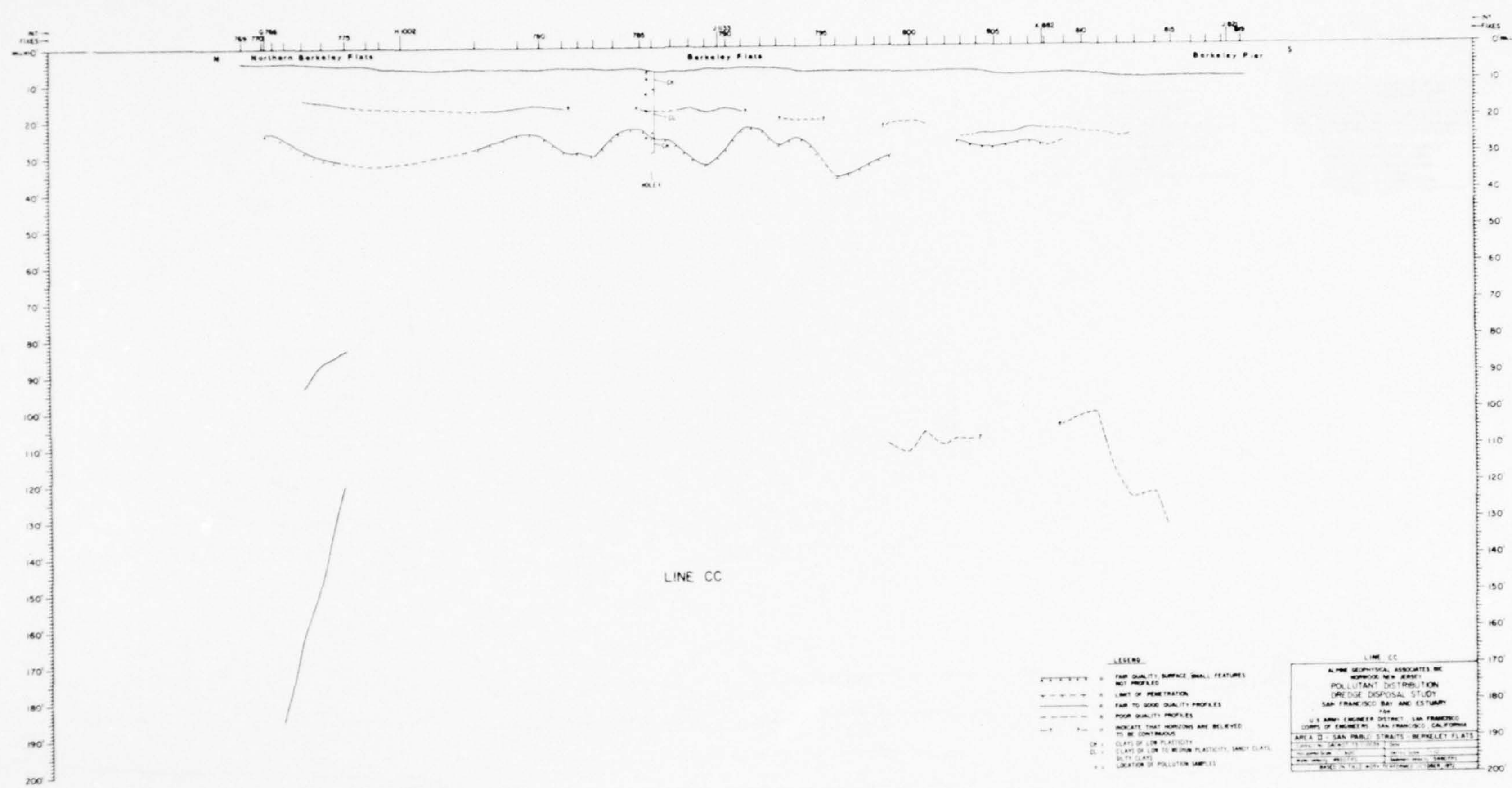

Point Chauncey
Tiburon Peninsula
Raccoon Strait
Bluff Point
Tiburon Peninsula
Raccoon Strait
West Richmond Channel
LINE HH
LINE J
LEGEND
= FAIR QUALITY, SURFACE, SMALL FEATURES NOT PROFILED
= LIMIT OF PENETRATION
= FAIR TO GOOD QUALITY PROFILES
= POOR QUALITY PROFILES
= INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINES HH - J
ALPINE GEOPHYSICAL ASSOCIATES, INC.
NORWOOD, NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS


Richmond – San Rafael Bridge
Red Rock to East
West Richmond Channel
Raccoon Strait
N
S
LINE GG
LEGEND
FAIR QUALITY, SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINE GG
ALPINE GEOPHYSICAL ASSOCIATES INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS

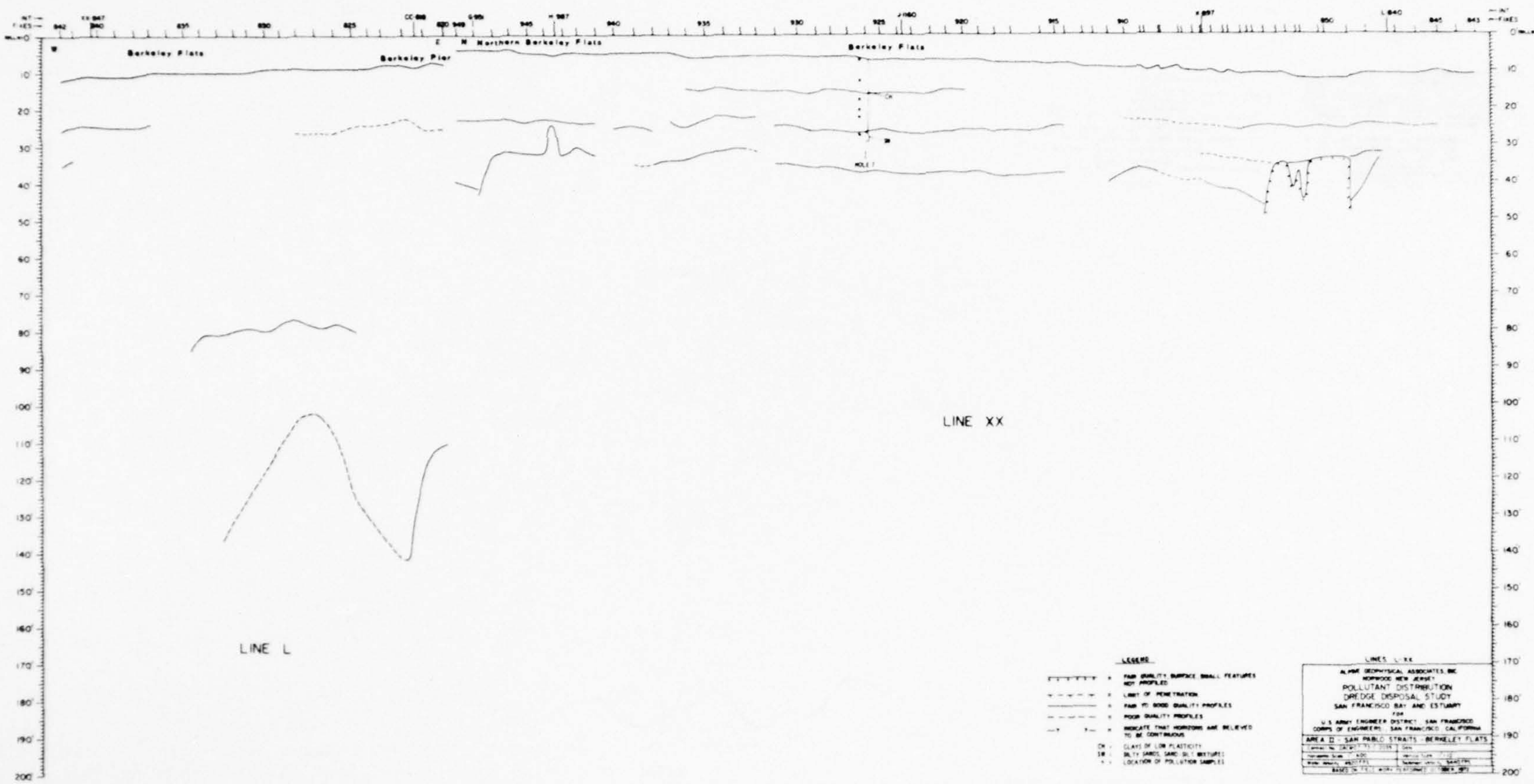

Richmond - San Rafael Bridge to North
Tiburon Peninsula
Paradise Cay
LINE JJ
LINE F
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINES JJ - F
ALPINE GEOPHYSICAL ASSOCIATES INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS

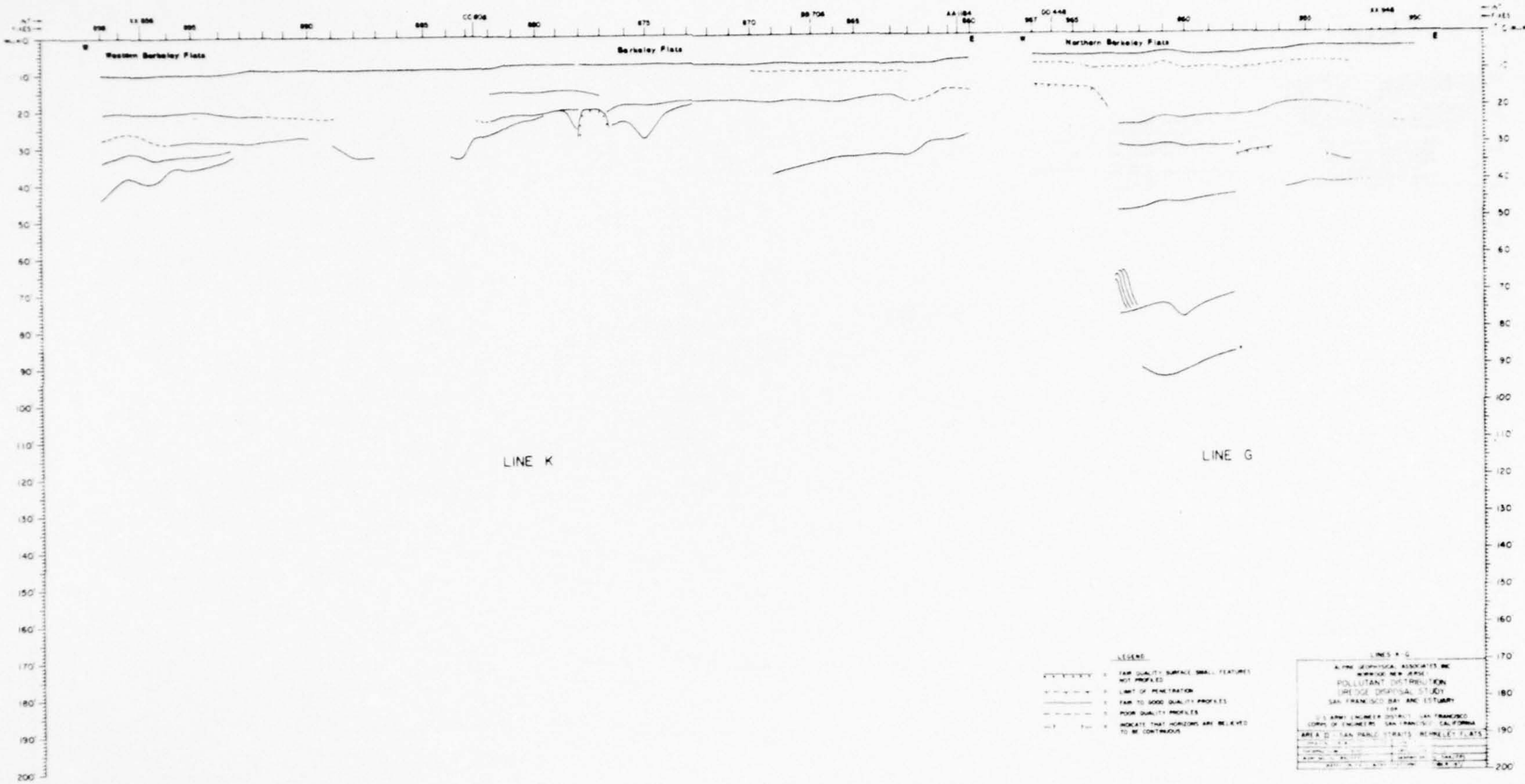

LINE F
West Richmond Channel
Southampton Channel
Richmond Entrance Channel
HOLE 1
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
CL = CLAYS OF LOW PLASTICITY
SC = CLAYEY SANDS, SAND-CLAY MIXTURES
LOCATION OF POLLUTION SAMPLES
LINE F
ALPINE GEOPHYSICAL ASSOCIATES, INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT SAN FRANCISCO
CORPS OF ENGINEERS SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS


Northern Berkeley Flats
Berkeley Flats
Berkeley Pier
POS. FAULT
LINE BB
LINE G
LEGEND
FAIR QUALITY, SURFACE, SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
CH - CLAYS OF LOW PLASTICITY
CL - CLAYS OF LOW TO MEDIUM PLASTICITY, SANDY CLAYS, SILTY CLAYS
LOCATION OF POLLUTION SAMPLES
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS

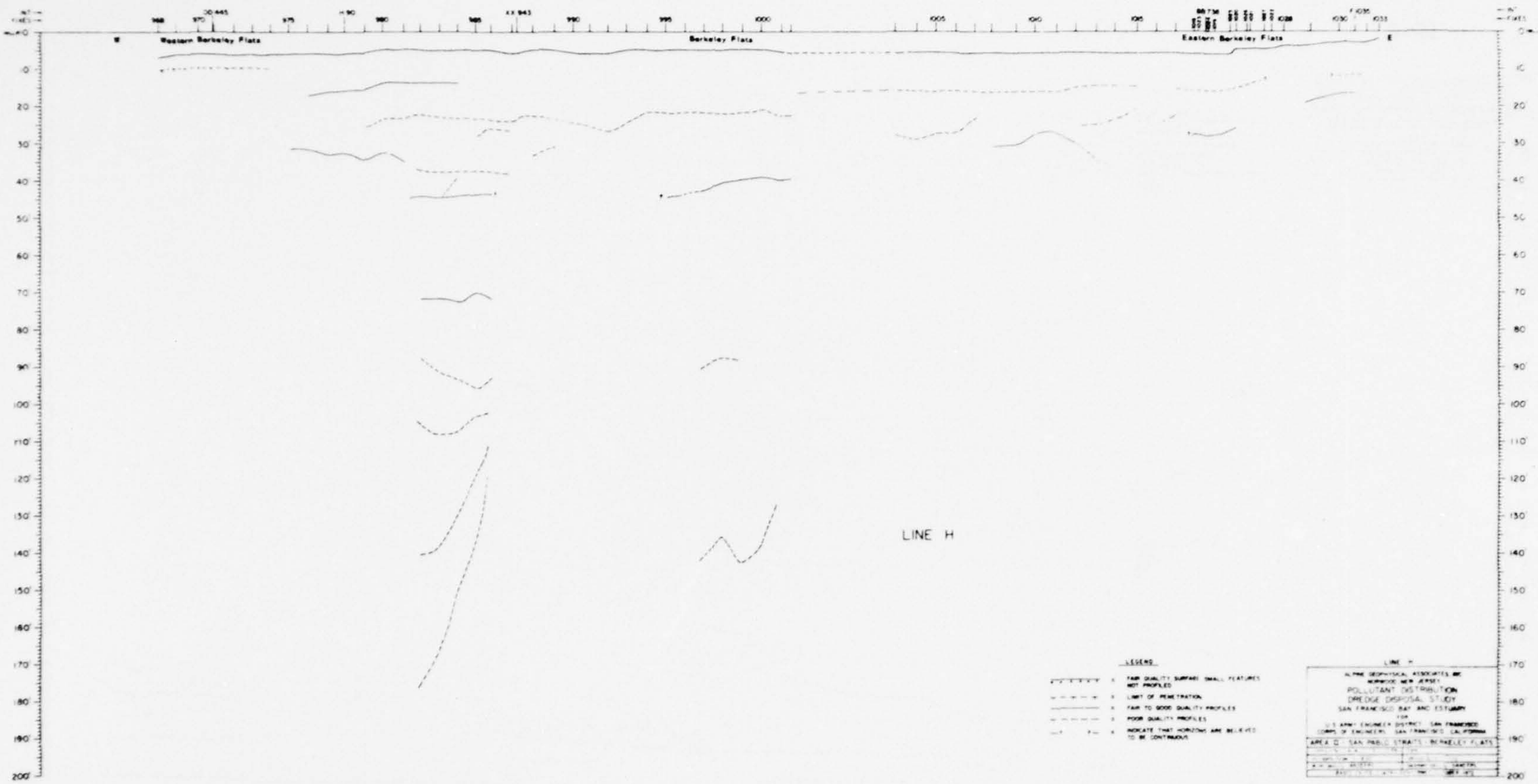


Northern Berkeley Flats
Berkeley Flats
Berkeley Pier
N
S
LINE CC
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
CH = CLAYS OF LOW PLASTICITY
CL = CLAYS OF LOW TO MEDIUM PLASTICITY, SANDY CLAYS, SILTY CLAYS
LOCATION OF POLLUTION SAMPLES
LINE CC
ALPINE GEOPHYSICAL ASSOCIATES INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS

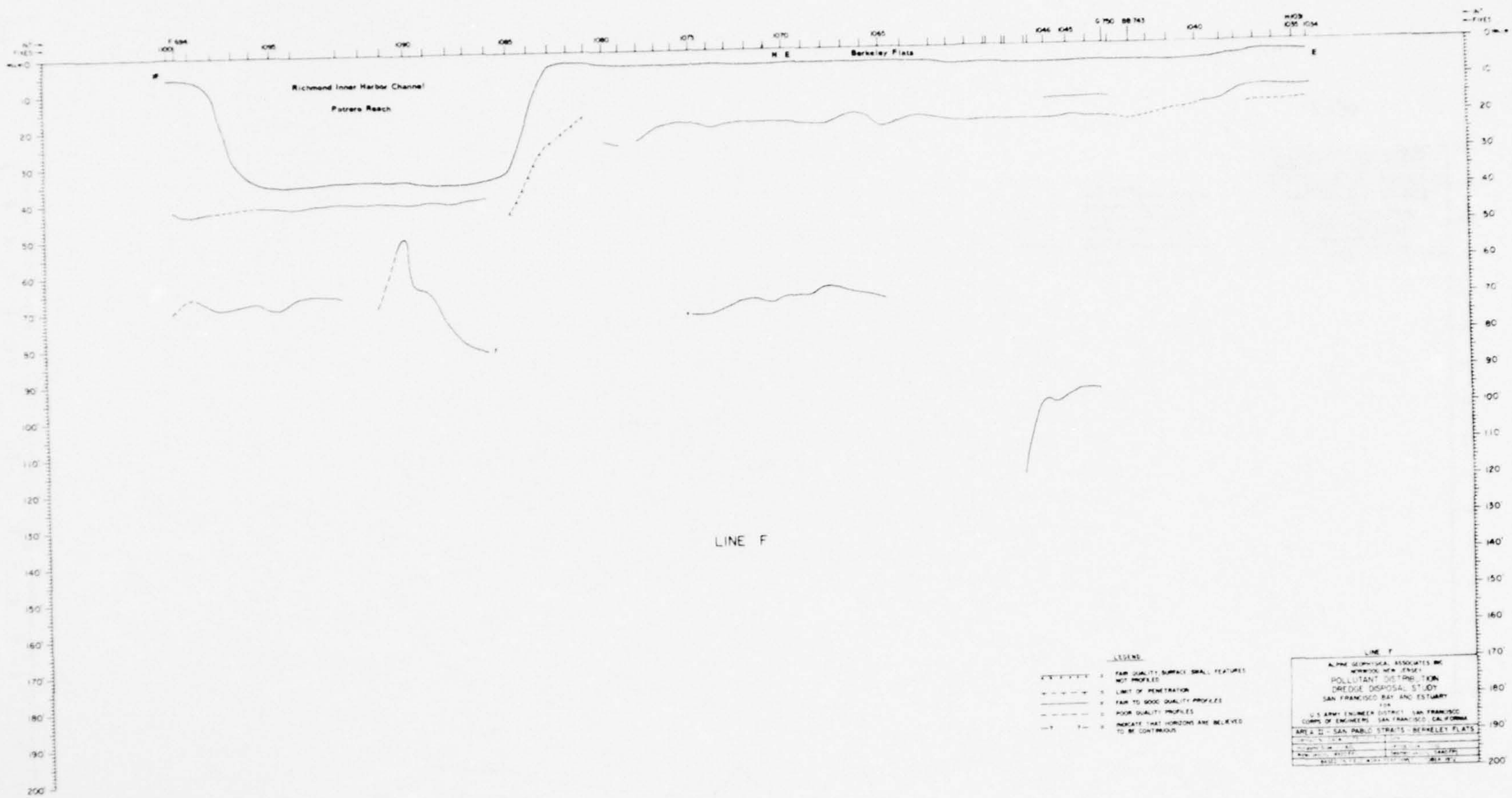

Berkeley Flats
Berkeley Pier
Northern Berkeley Flats
Berkeley Flats
HOLE 1
LINE XX
LINE L
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
CH - CLAYS OF LOW PLASTICITY
SM - SILTY SANDS, SAND-SILT MIXTURES
LOCATION OF POLLUTION SAMPLES
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS

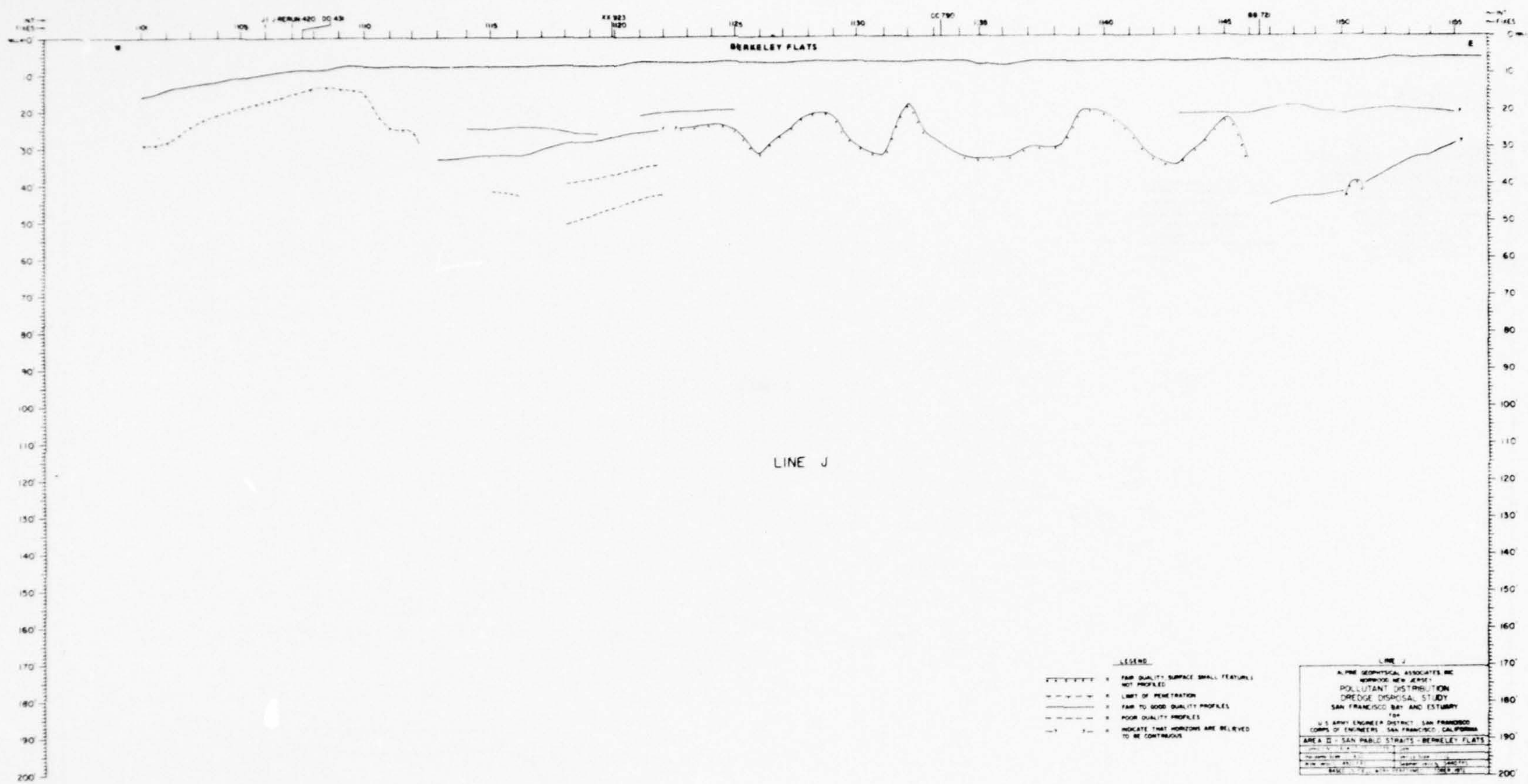


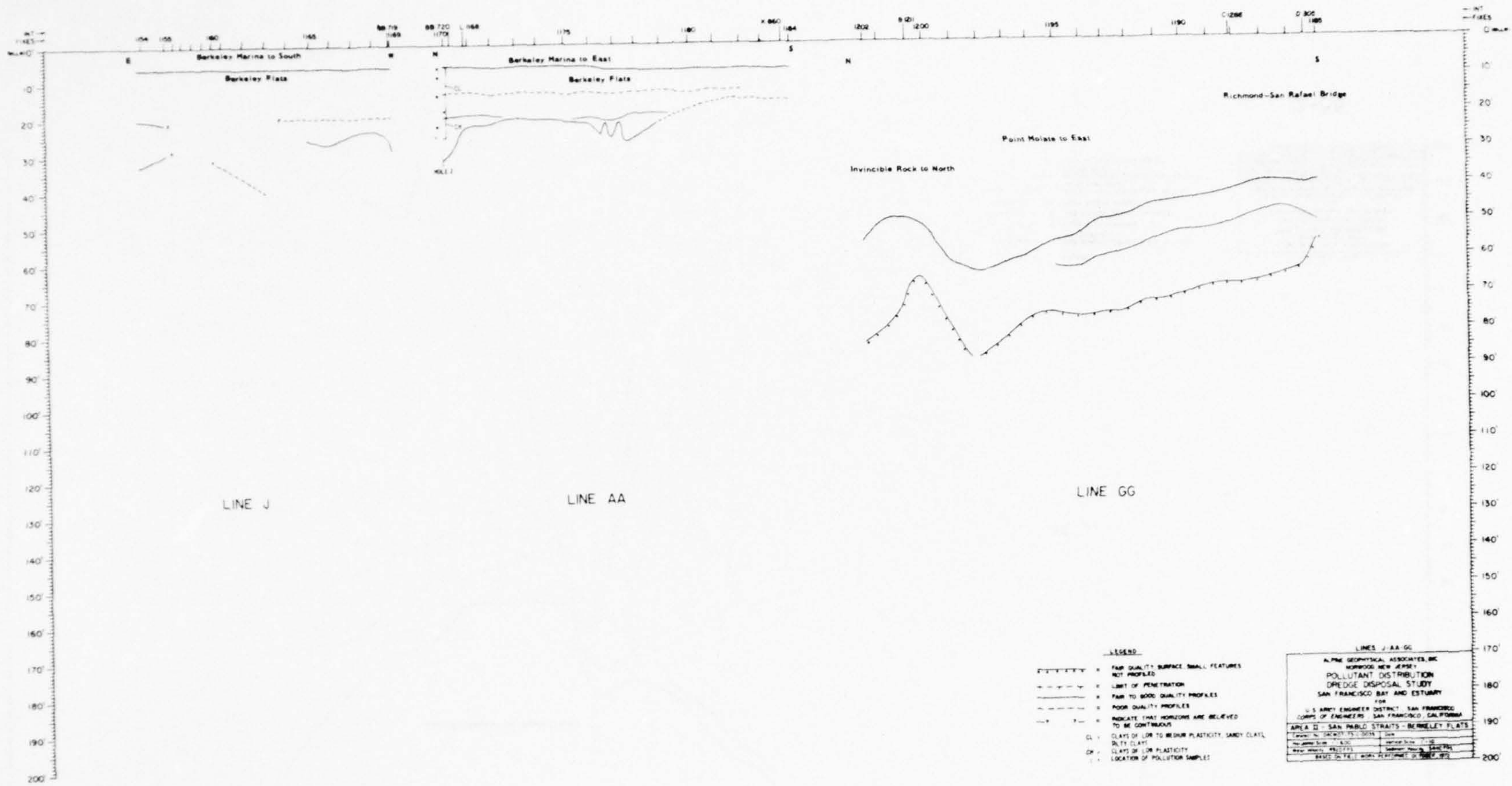
Western Berkeley Flats
Berkeley Flats
Northern Berkeley Flats
LINE K
LINE G
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
CORPS OF ENGINEERS SAN FRANCISCO CALIFORNIA



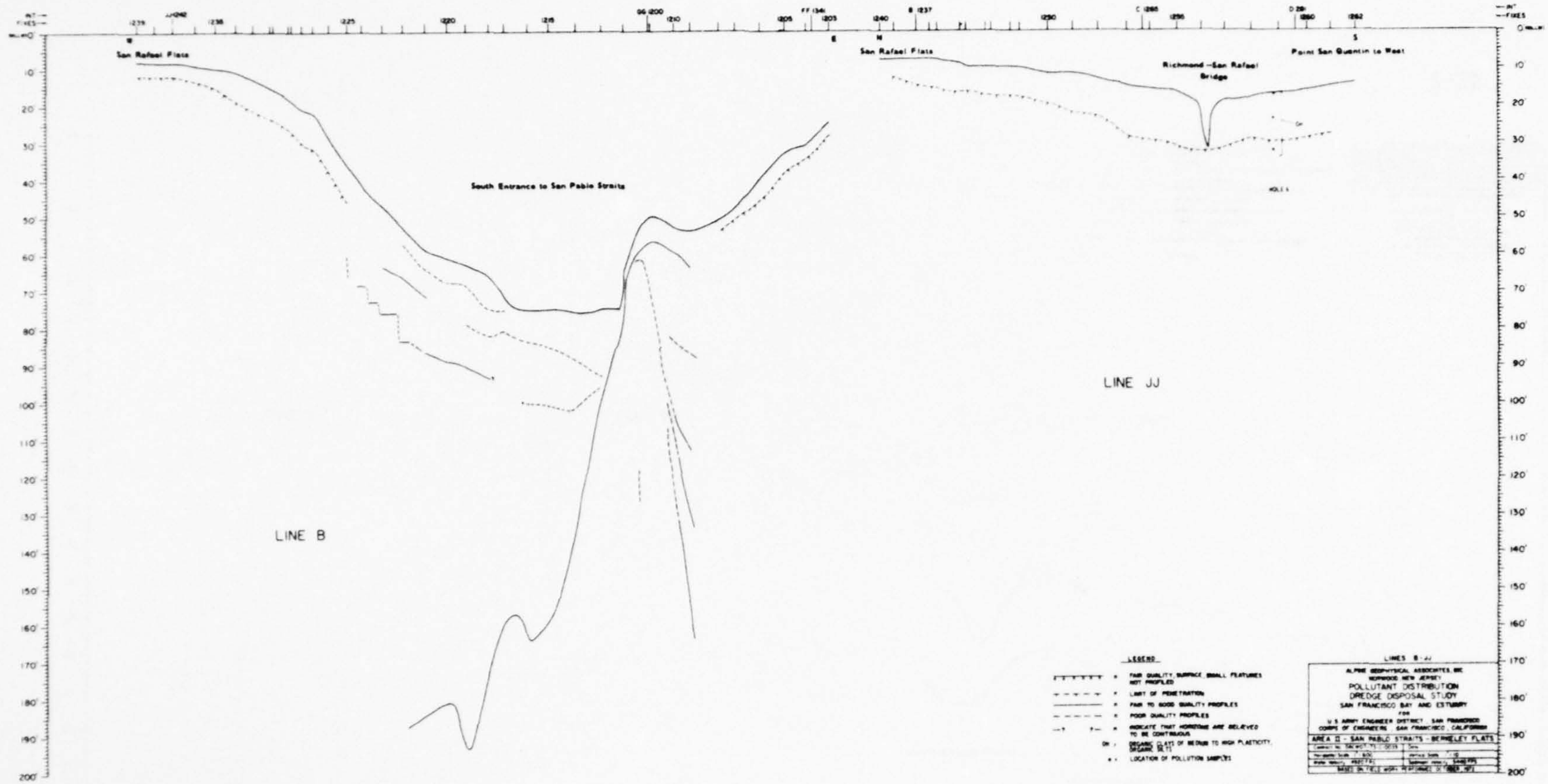
Western Berkeley Flats
Berkeley Flats
Eastern Berkeley Flats
W
E
LINE H
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
ALPINE GEOPHYSICAL ASSOCIATES INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA II · SAN PABLO STRAITS · BERKELEY FLATS

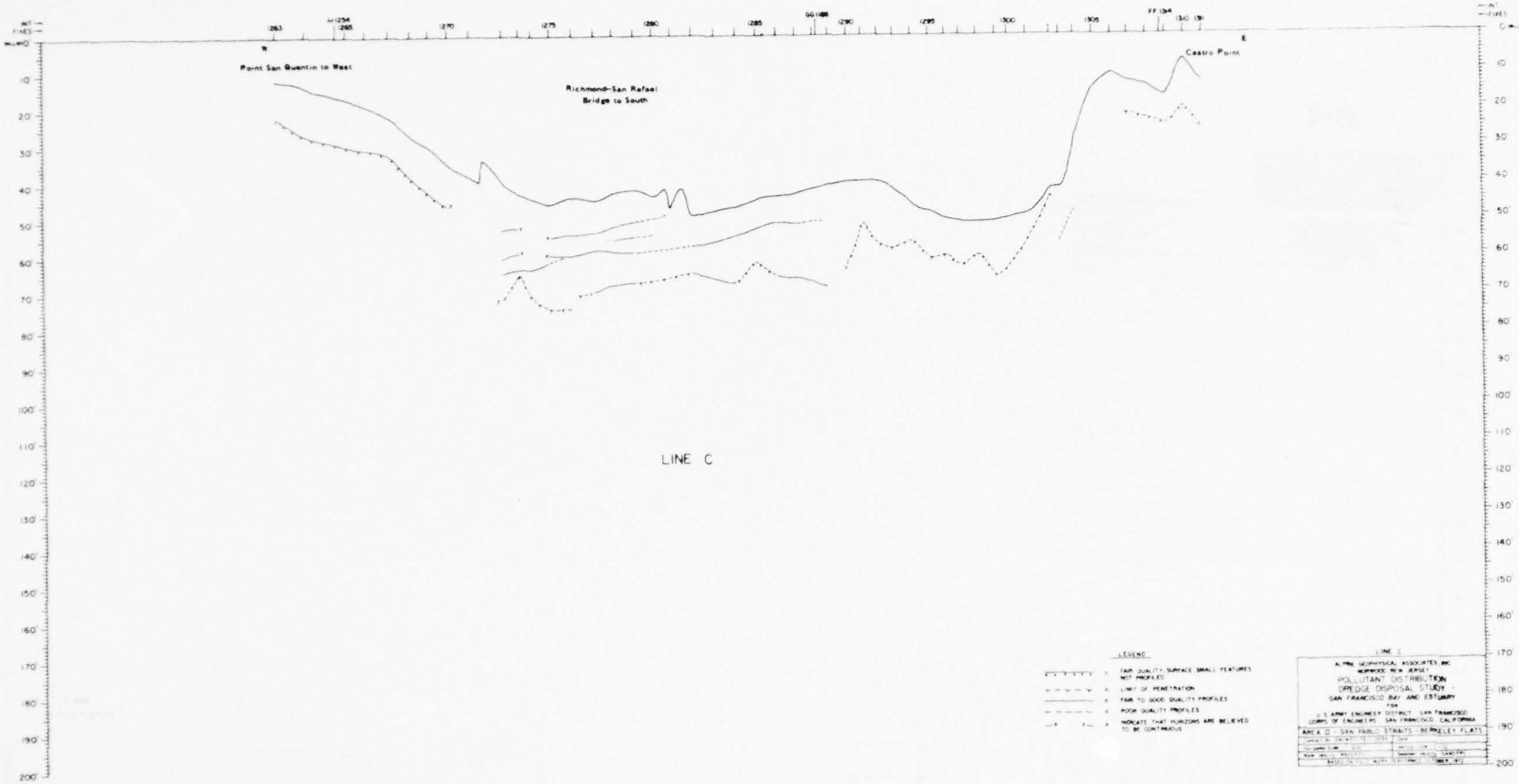

Richmond Inner Harbor Channel
Potrero Reach
Berkeley Flats
LINE F
LEGEND
FAIR QUALITY, SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINE F
ALPINE GEOPHYSICAL ASSOCIATES INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS

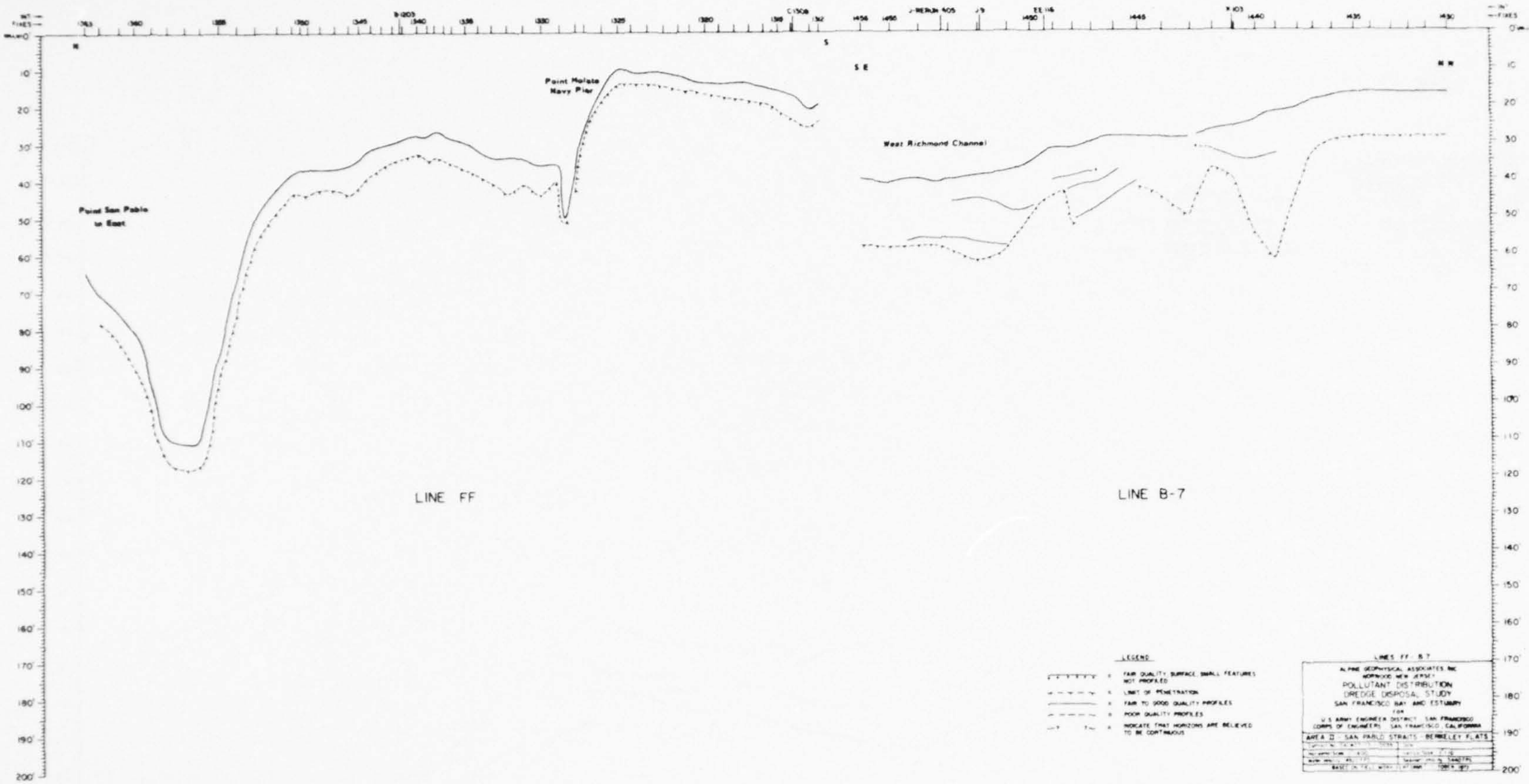

BERKELEY FLATS
LINE J
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINE J
ALPINE GEOPHYSICAL ASSOCIATES INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS

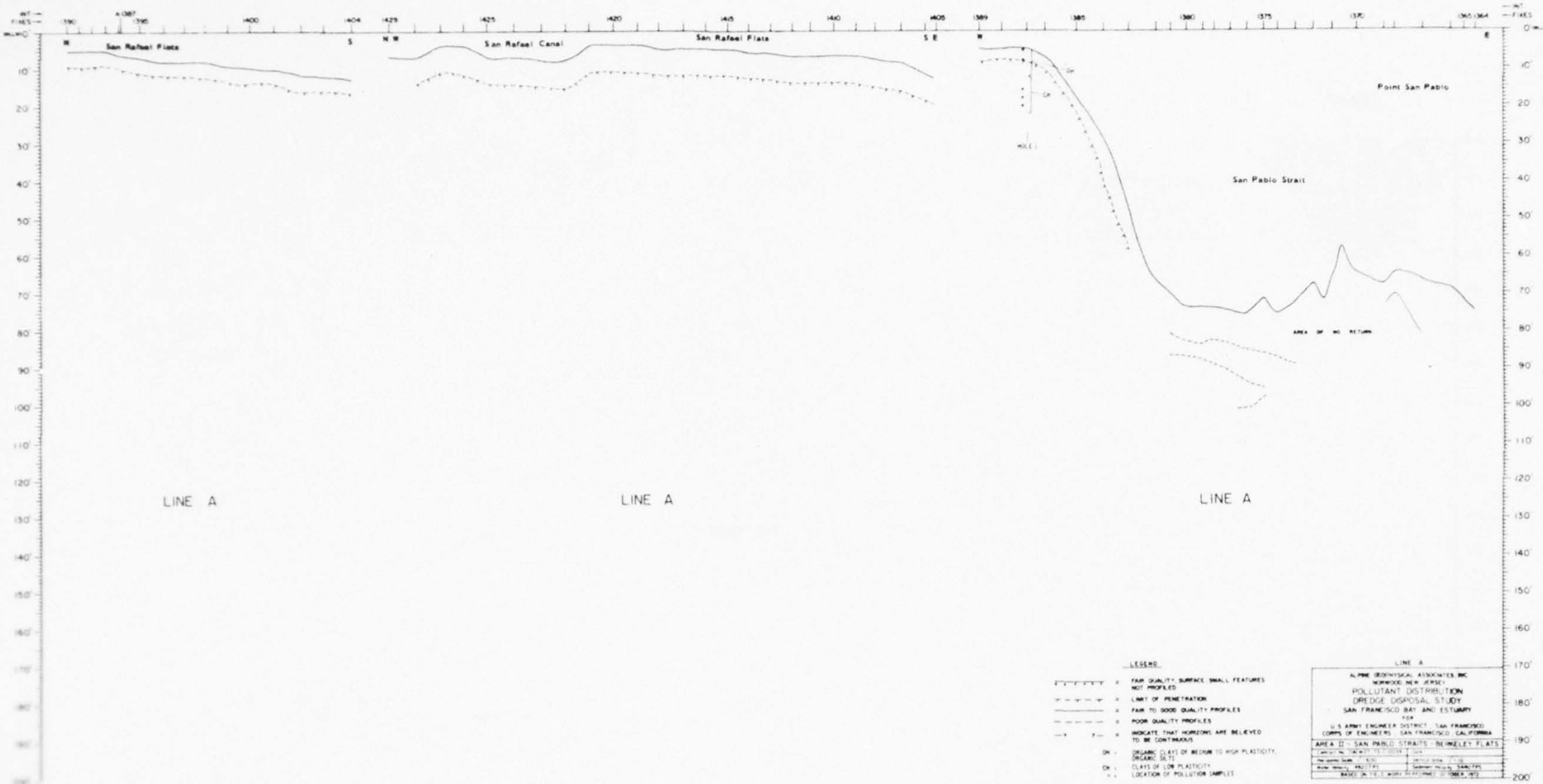


Berkeley Marina to South
Berkeley Flats
Berkeley Marina to East
Berkeley Flats
Richmond–San Rafael Bridge
Point Molate to East
Invincible Rock to North
LINE J
LINE AA
LINE GG
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
CL = CLAYS OF LOW TO MEDIUM PLASTICITY, SANDY CLAYS, SILTY CLAYS
CP = CLAYS OF LOW PLASTICITY
LOCATION OF POLLUTION SAMPLES
LINES J-AA-GG
ALPINE GEOPHYSICAL ASSOCIATES, INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS


San Rafael Flats
South Entrance to San Pablo Straits
LINE B
San Rafael Flats
Richmond - San Rafael Bridge
Point San Quentin to West
LINE JJ
LEGEND
FAIR QUALITY, SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
LOCATION OF POLLUTION SAMPLES
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
AREA II - SAN PABLO STRAITS - BERKELEY FLATS


Point San Quentin to West
Richmond-San Rafael
Bridge to South
Castro Point
W
E
LINE C
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINE C
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS


LINE FF
LINE B-7
Point San Pablo to East
Point Molate Navy Pier
West Richmond Channel
S E
N W
LEGEND
FAIR QUALITY SURFACE, SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINES FF B-7
ALPINE GEOPHYSICAL ASSOCIATES, INC.
NORWOOD, NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS

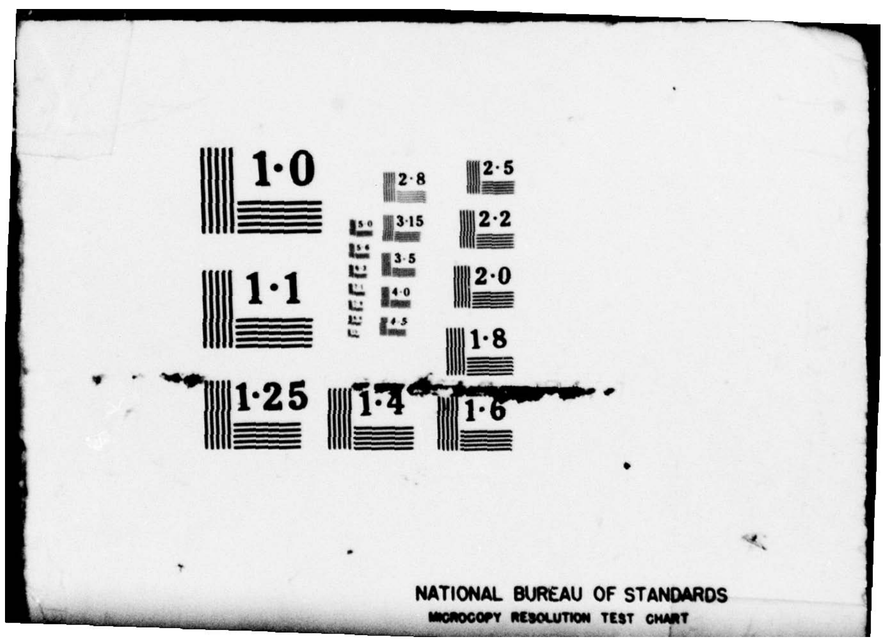


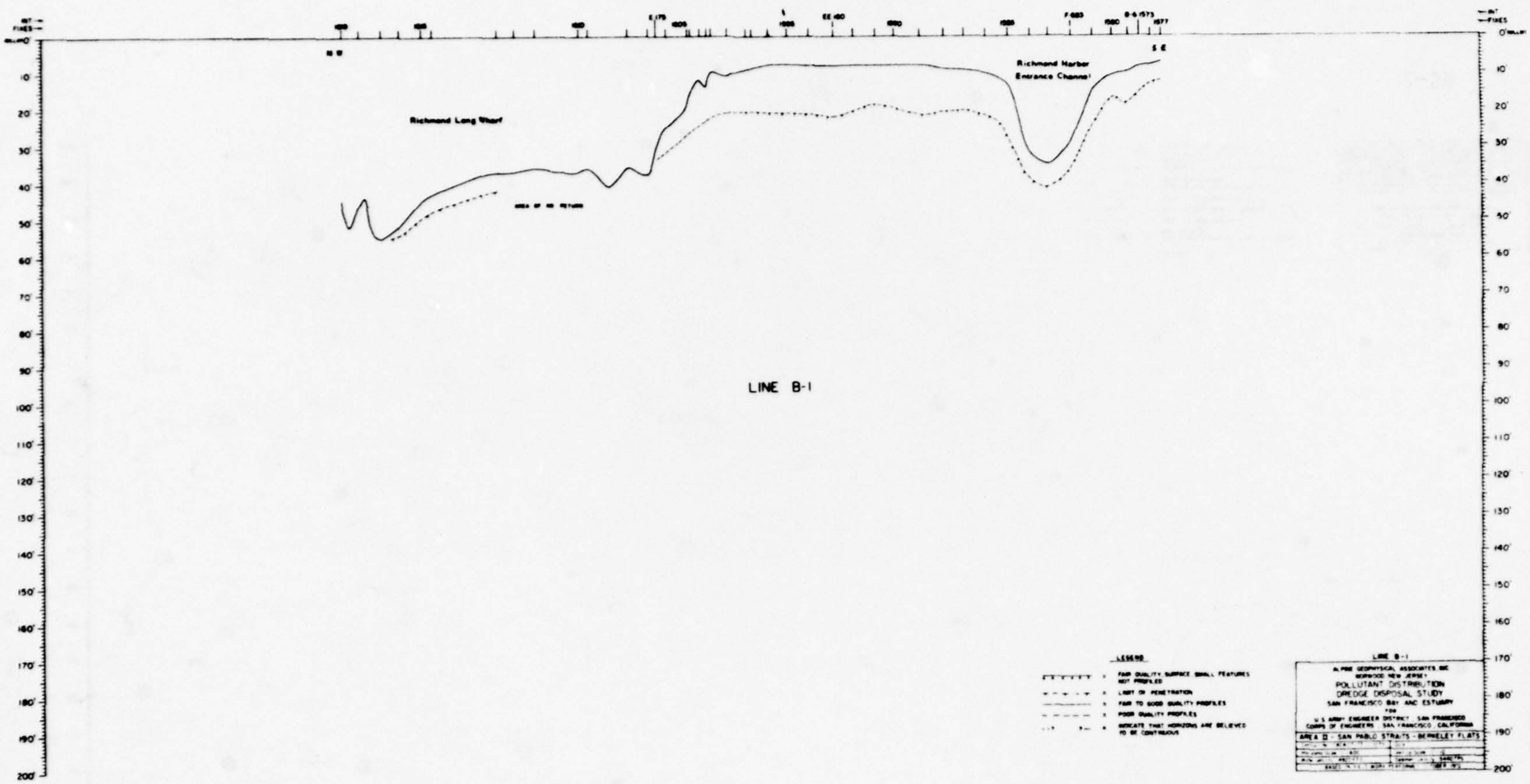
San Rafael Flats
San Rafael Canal
San Rafael Flats
Point San Pablo
San Pablo Strait
AREA OF NO RETURN
LINE A
LINE A
LINE A
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
OH : ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
CH : CLAYS OF LOW PLASTICITY
LOCATION OF POLLUTION SAMPLES
LINE A
ALPINE GEOPHYSICAL ASSOCIATES, INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS

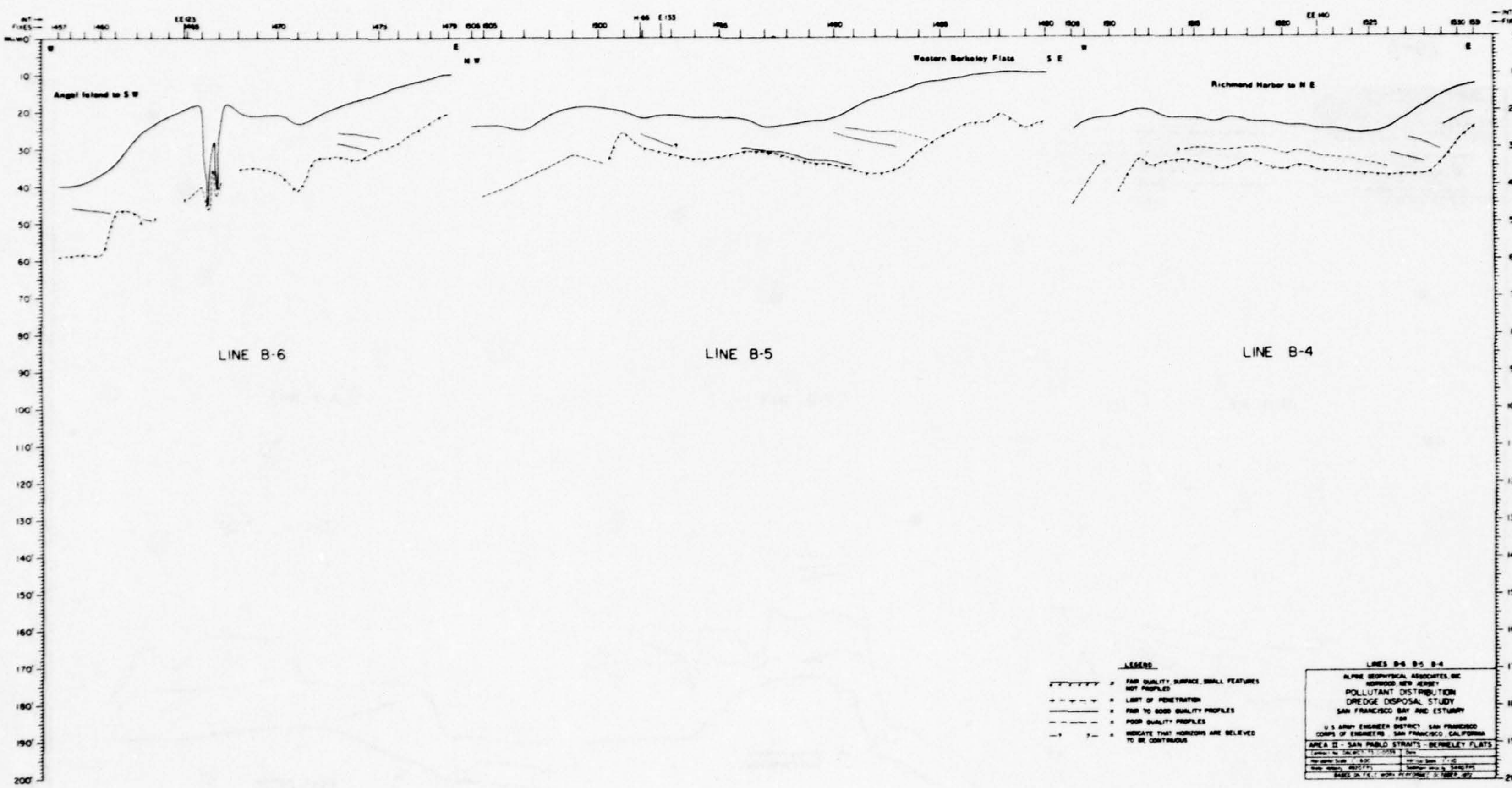
AD-A071 722 CORPS OF ENGINEERS SAN FRANCISCO CALIF SAN FRANCISCO--ETC F/G 13/3
DREDGE DISPOSAL STUDY. SAN FRANCISCO BAY AND ESTUARY. APPENDIX --ETC(U)
MAY 79 R M ECKER, J F SUSTAR, J HENDRICKS

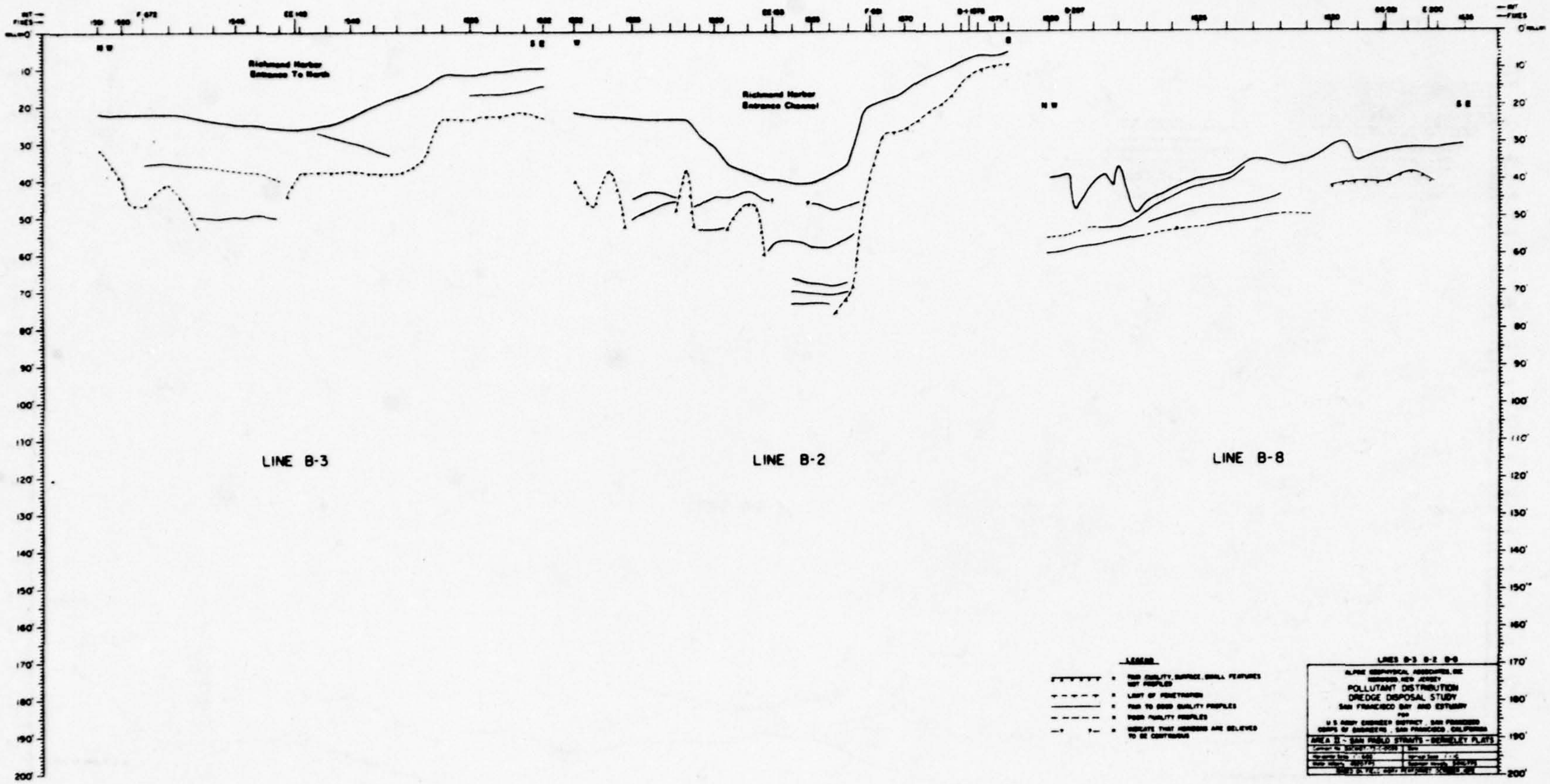
UNCLASSIFIED NL

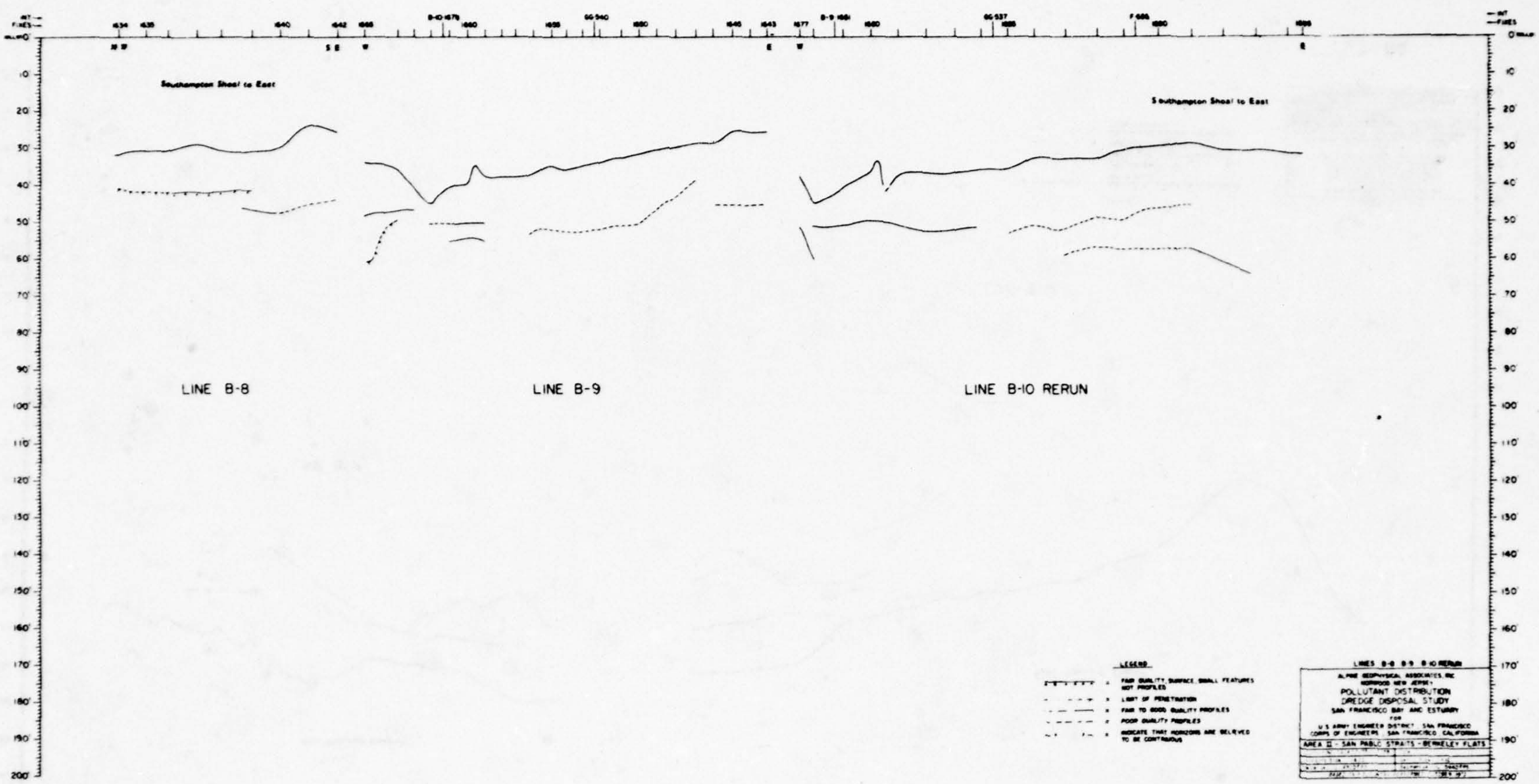
5 OF 6
AD
A071722


1·0
1·1
1·25
1·4
1·6
1·8
2·0
2·2
2·5
2·8
3·15
3·5
4·0
4·5
5·0
5·6
NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

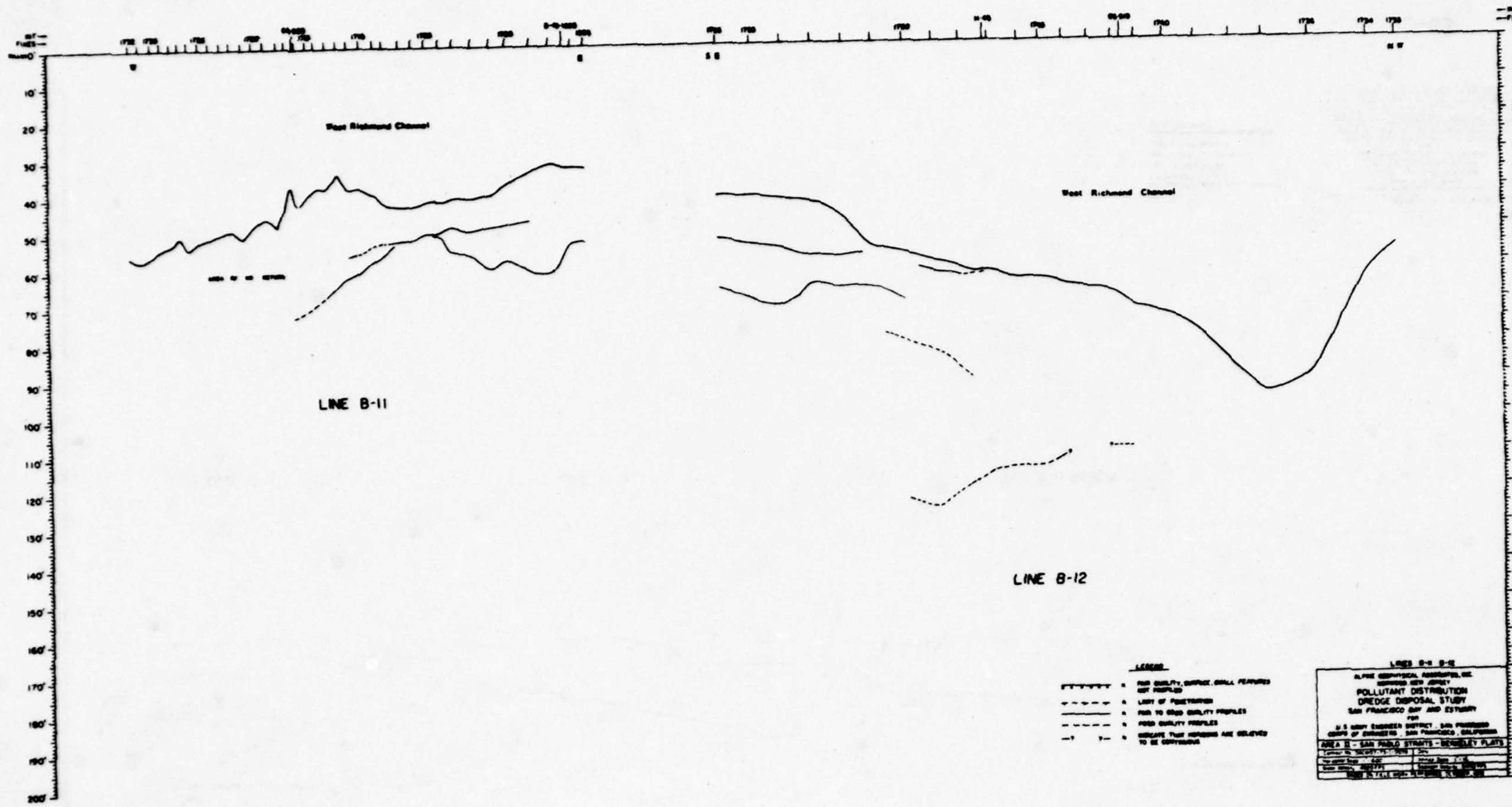

Richmond Long Wharf
Richmond Harbor
Entrance Channel
N W
S E
LINE B-1
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINE B-1
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS

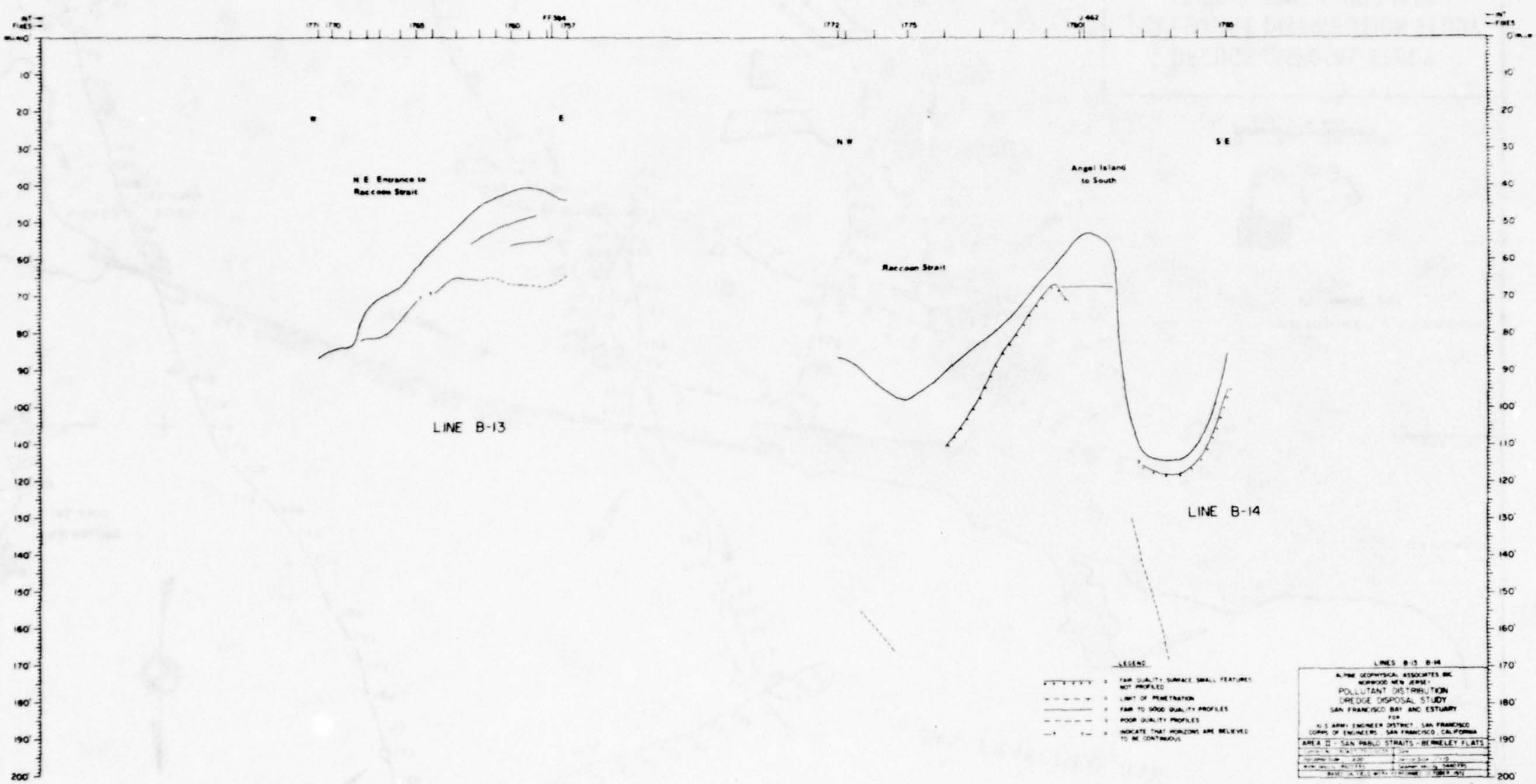

Angel Island to S W
Western Berkeley Flats
S E
N W
Richmond Harbor to N E
LINE B-6
LINE B-5
LINE B-4
LEGEND
FAIR QUALITY SURFACE, SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINES B-6 B-5 B-4
ALPINE GEOPHYSICAL ASSOCIATES, INC.
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT SAN FRANCISCO
CORPS OF ENGINEERS SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS

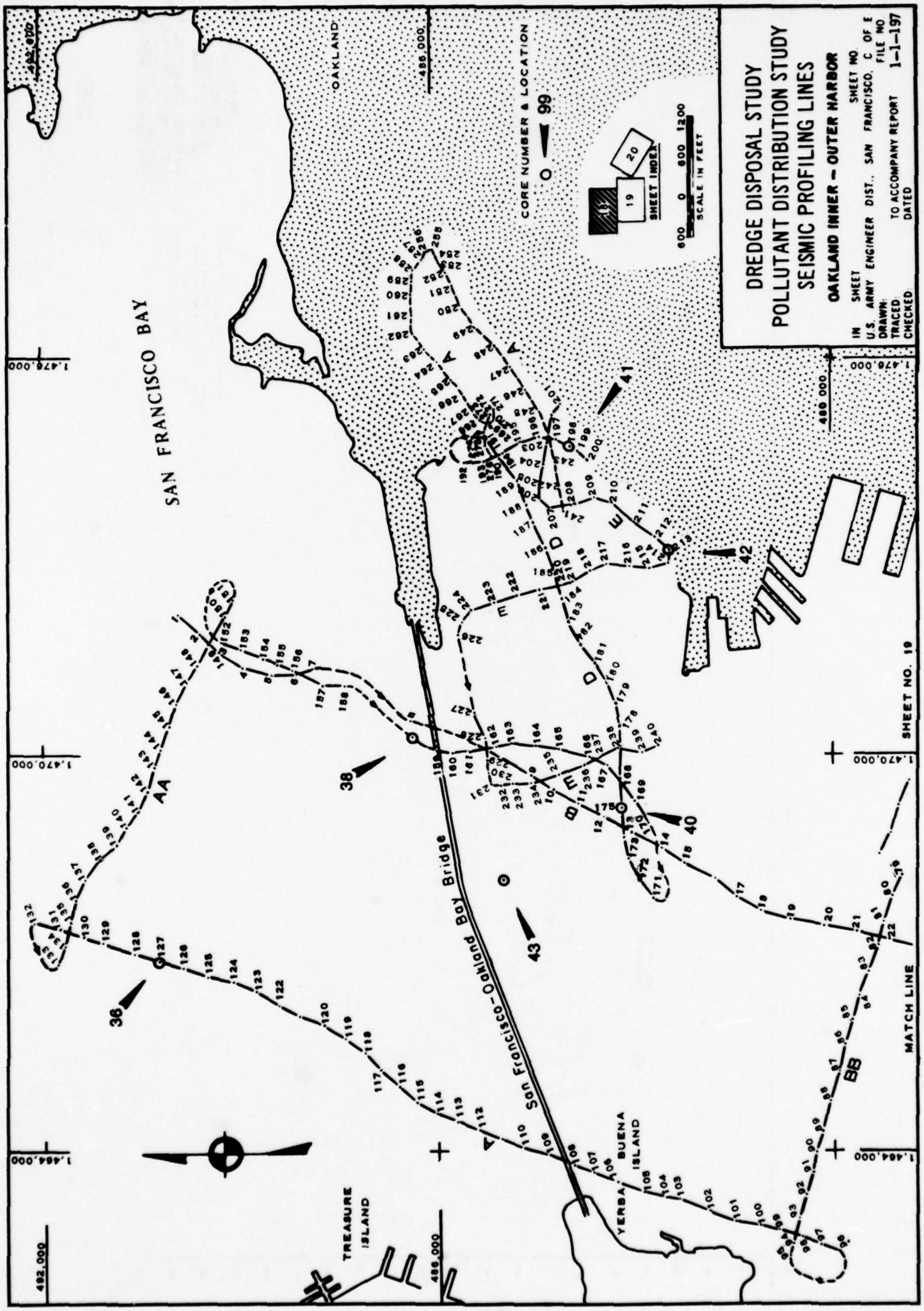

Richmond Harbor
Entrance To North
Richmond Harbor
Entrance Channel
LINE B-3
LINE B-2
LINE B-8
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY

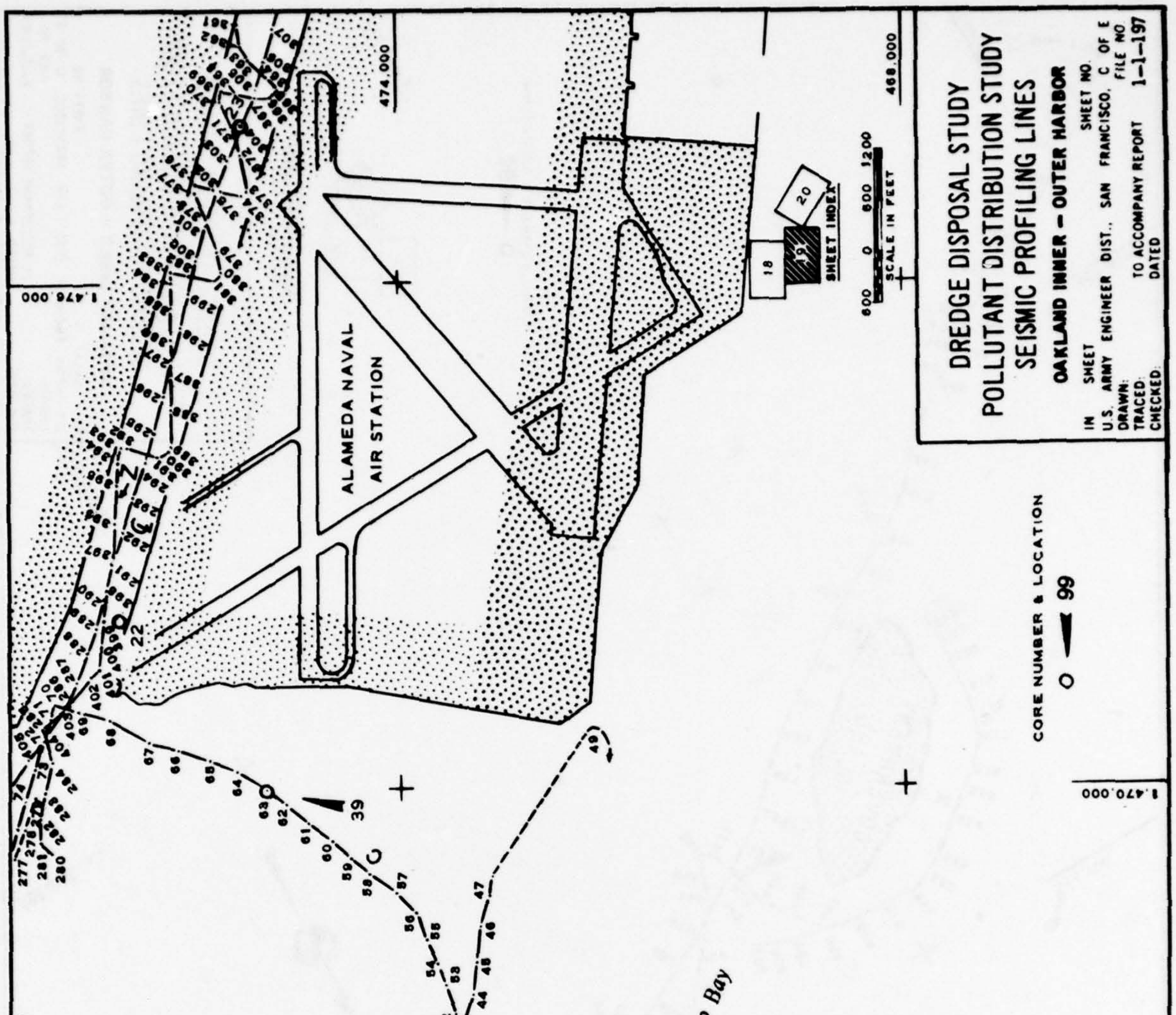


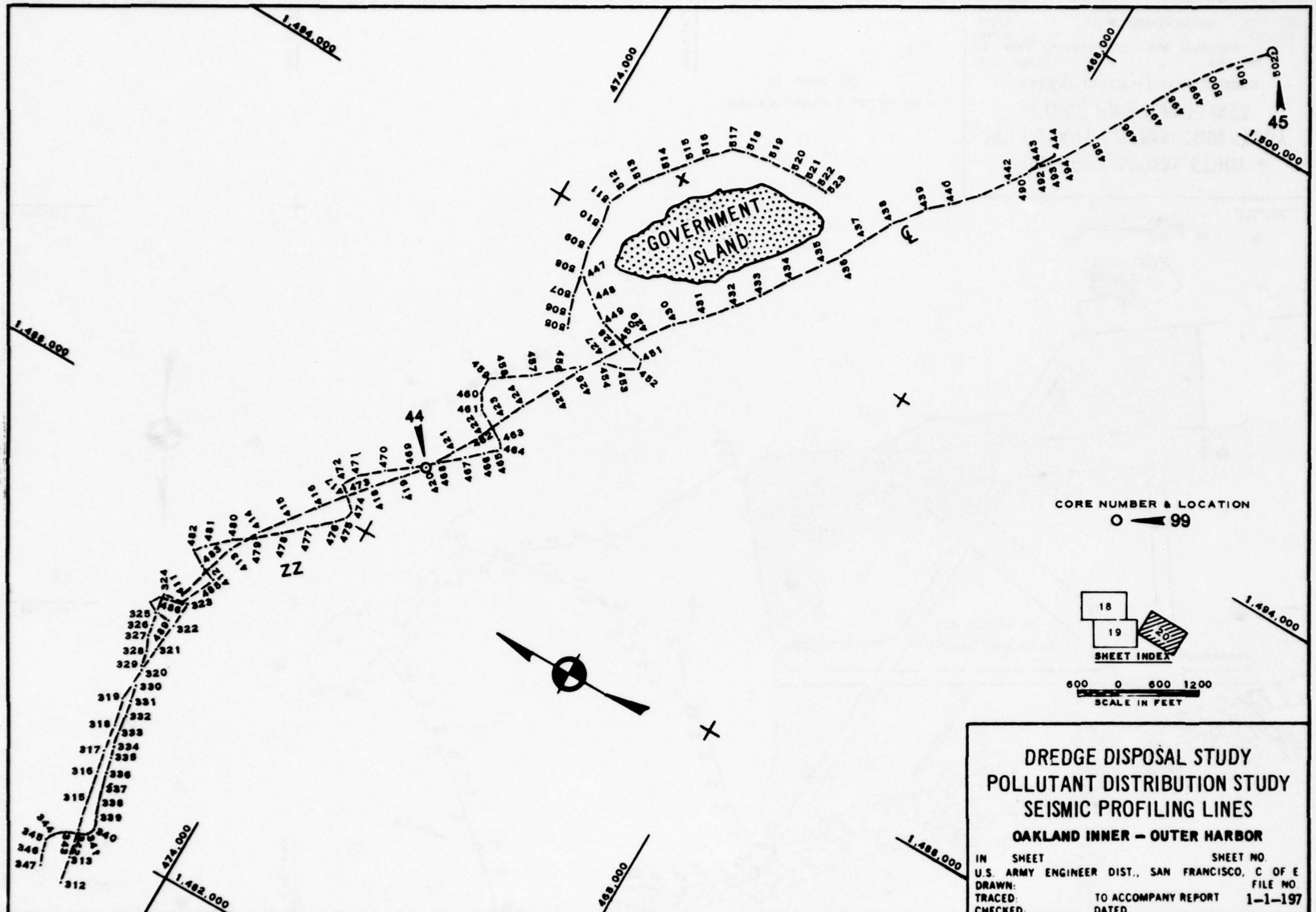
Southampton Shoal to East
Southampton Shoal to East
LINE B-8
LINE B-9
LINE B-10 RERUN
LEGEND
FAIR QUALITY, SURFACE, SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINES B-8 B-9 B-10 RERUN
ALPINE GEOPHYSICAL ASSOCIATES, INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS


West Richmond Channel
LINE B-11
West Richmond Channel
LINE B-12
LEGEND
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
TO BE CONTINUOUS
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
AREA II - SAN PABLO STRAITS - BERKELEY FLATS

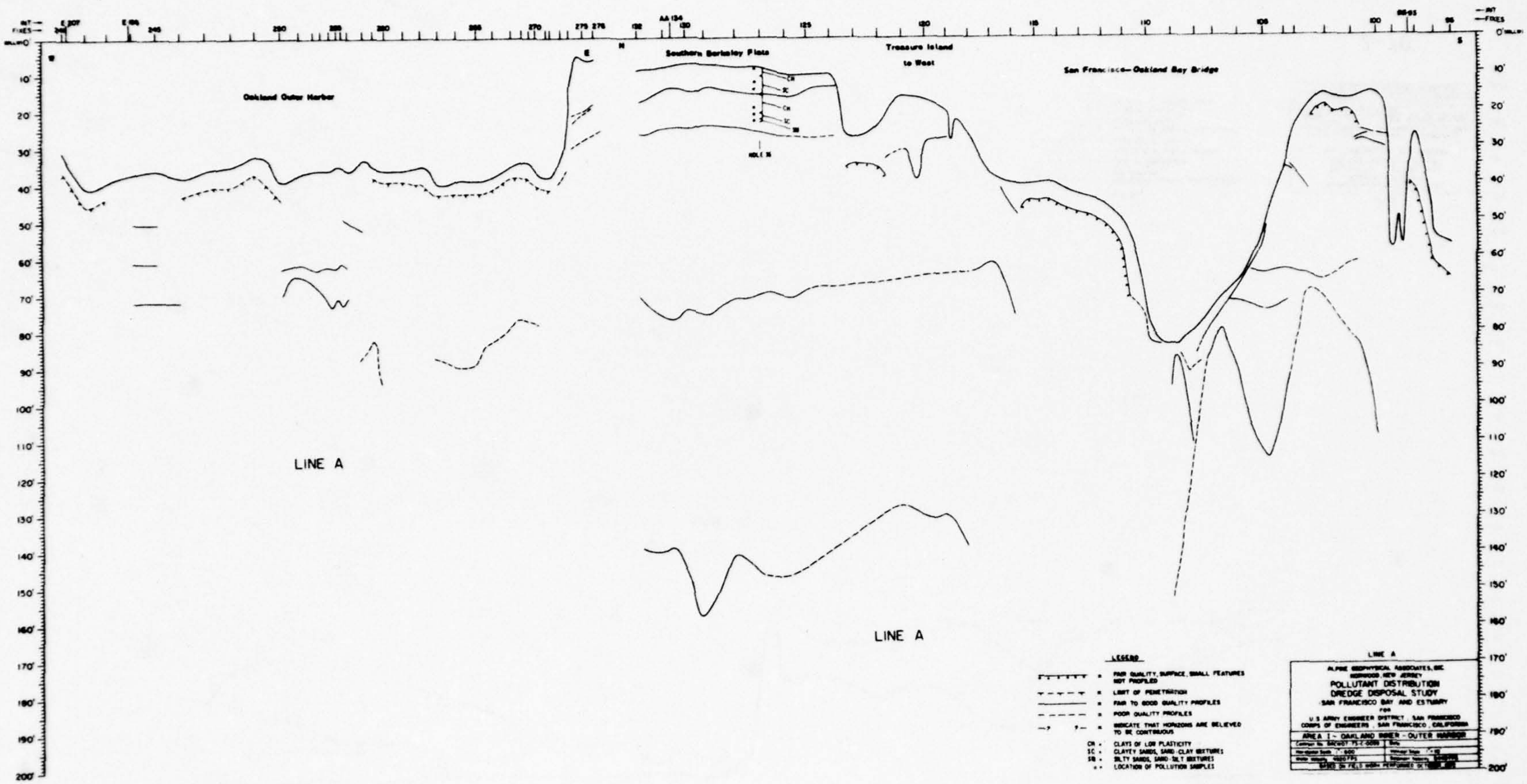

W
E
N.E. Entrance to
Raccoon Strait
LINE B-13
N.W.
Raccoon Strait
Angel Island
to South
S.E.
LINE B-14
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINES B-13 B-14
ALPINE GEOPHYSICAL ASSOCIATES INC.
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA II - SAN PABLO STRAITS - BERKELEY FLATS

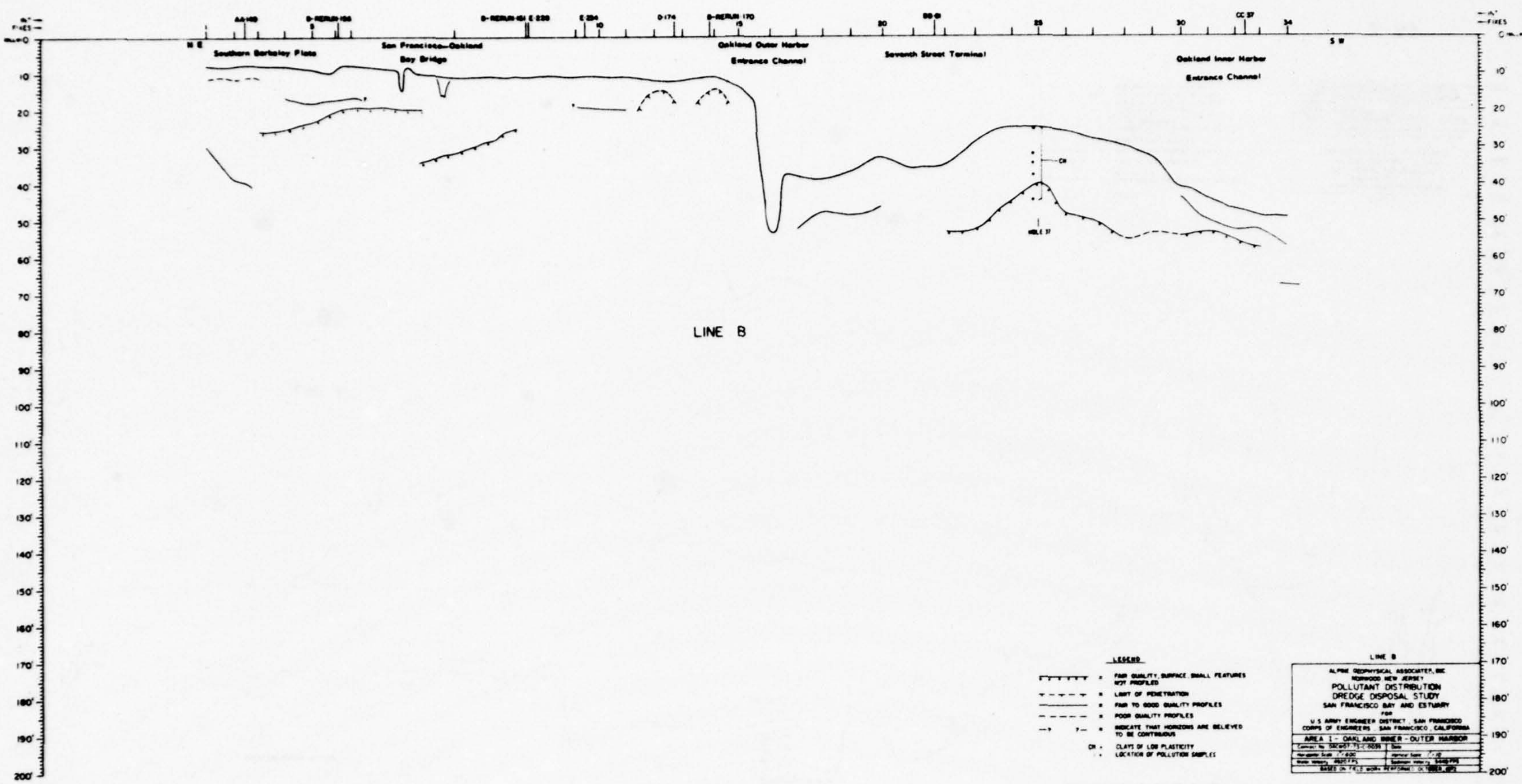

DREDGE DISPOSAL STUDY
POLLUTANT DISTRIBUTION STUDY
SEISMIC PROFILING LINES
OAKLAND INNER – OUTER HARBOR
U.S. ARMY ENGINEER DIST., SAN FRANCISCO. C OF E
FILE NO
1-1-197
TO ACCOMPANY REPORT
DATED
DRAWN:
TRACED:
CHECKED:
SHEET NO.
CORE NUMBER & LOCATION
SHEET INDEX
SCALE IN FEET
SAN FRANCISCO BAY
OAKLAND
San Francisco–Oakland Bay Bridge
TREASURE ISLAND
YERBA BUENA ISLAND
MATCH LINE
SHEET NO. 19

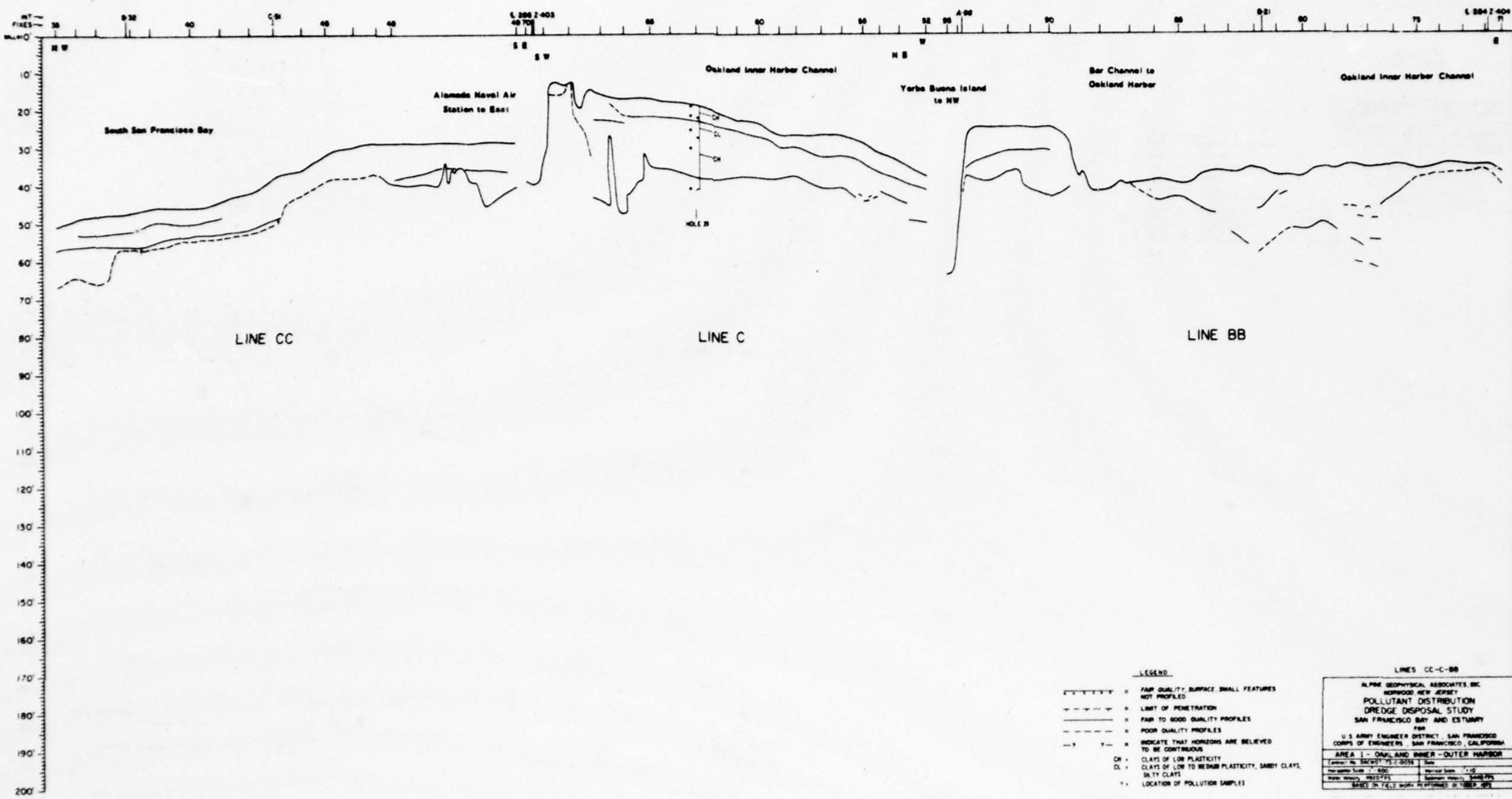

DREDGE DISPOSAL STUDY
POLLUTANT DISTRIBUTION STUDY
SEISMIC PROFILING LINES
OAKLAND INNER – OUTER HARBOR
IN SHEET SHEET NO.
U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E FILE NO 1-1-197
DRAWN:
TRACED: TO ACCOMPANY REPORT
CHECKED: DATED
SHEET INDEX
18
19
20
SCALE IN FEET
600 0 600 1200
ALAMEDA NAVAL AIR STATION
San Francisco Bay
CORE NUMBER & LOCATION
99
474,000
468,000
1,476,000
1,470,000
1,464,000

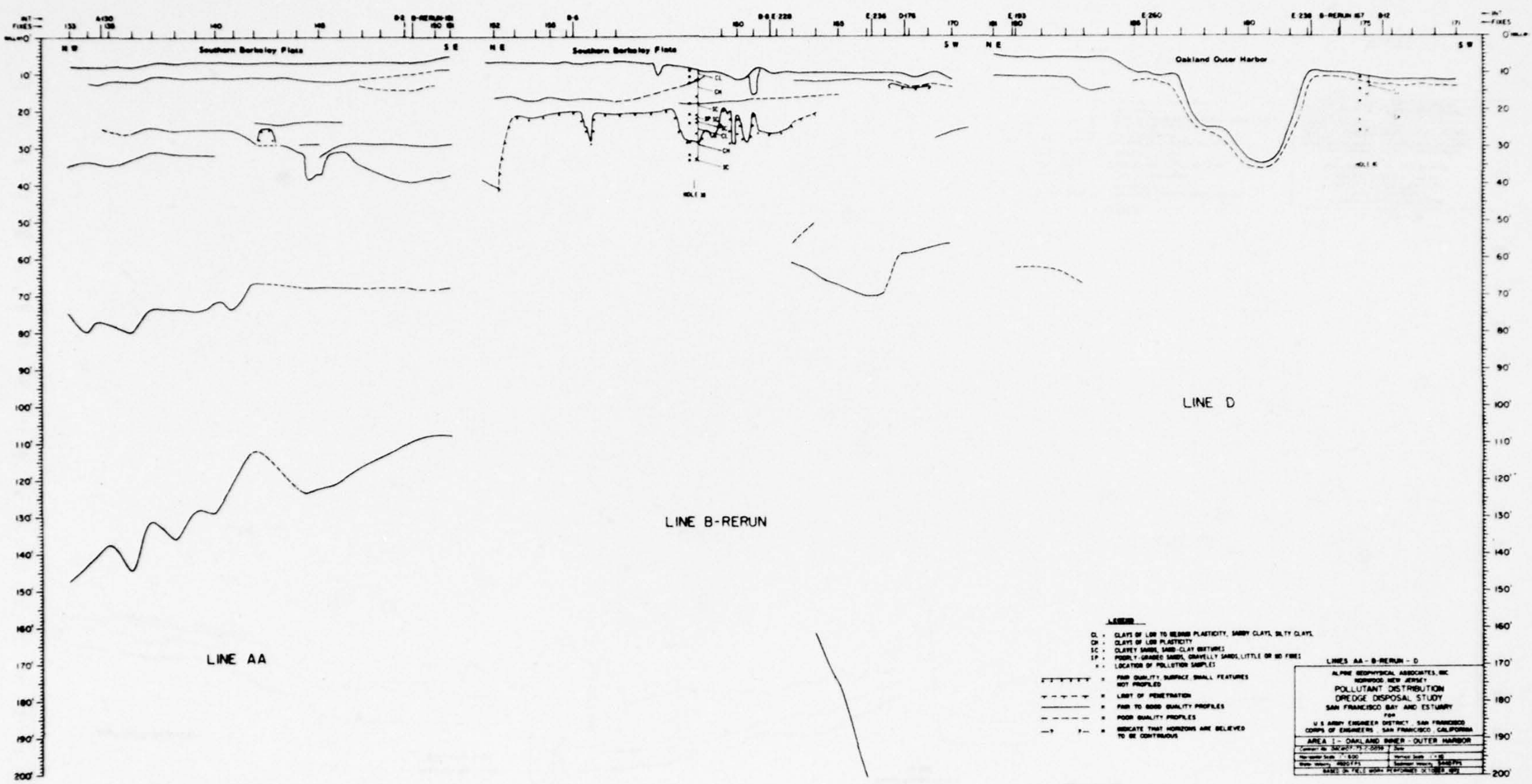


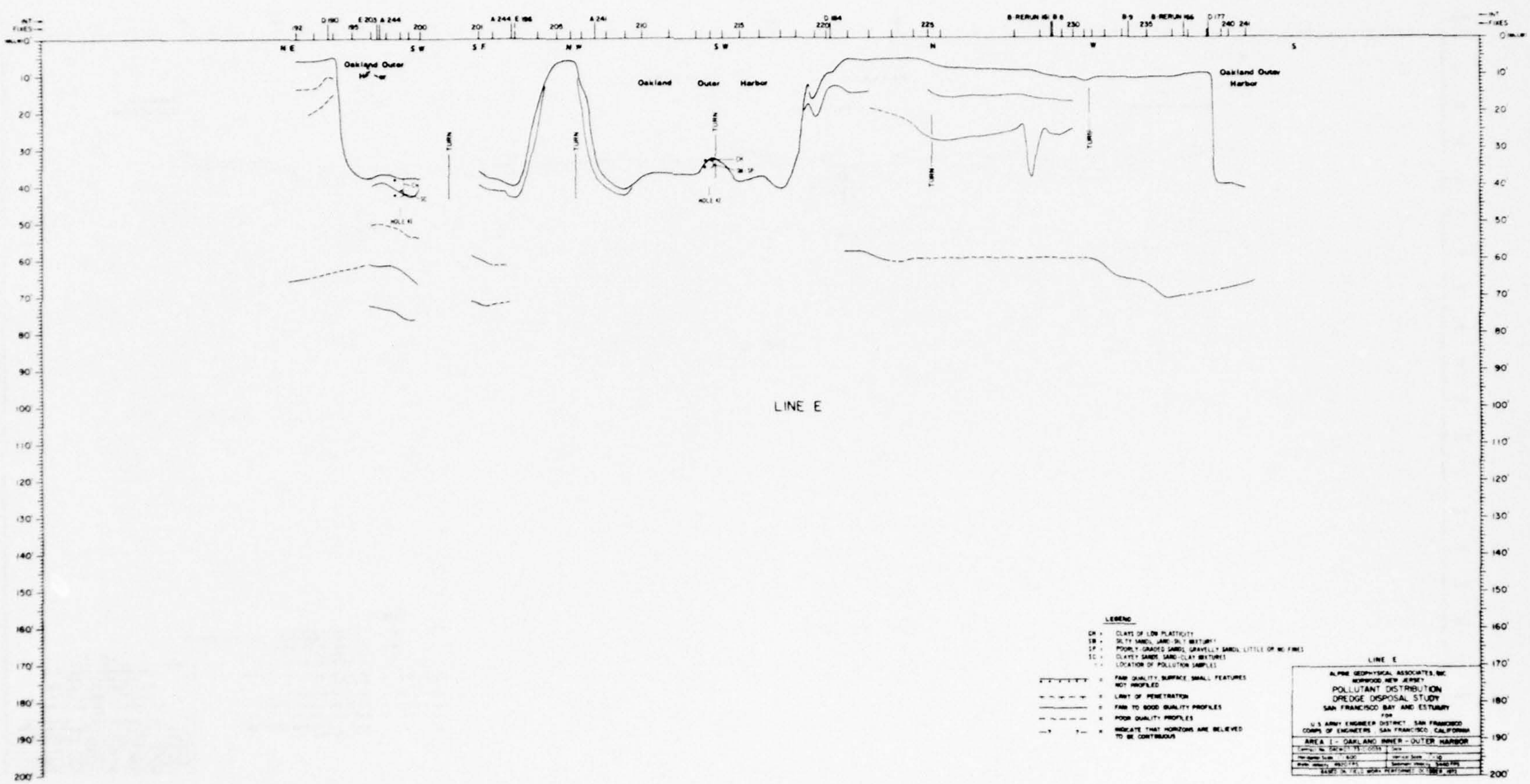
DREDGE DISPOSAL STUDY
POLLUTANT DISTRIBUTION STUDY
SEISMIC PROFILING LINES
OAKLAND INNER – OUTER HARBOR
IN SHEET SHEET NO.
U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E
DRAWN: FILE NO
TRACED: TO ACCOMPANY REPORT 1-1-197
CHECKED: DATED
GOVERNMENT ISLAND
CORE NUMBER & LOCATION
99
SHEET INDEX
18
19
20
600 0 600 1200
SCALE IN FEET
44
45
ZZ
1,494,000
1,488,000
1,482,000
1,800,000
474,000
468,000

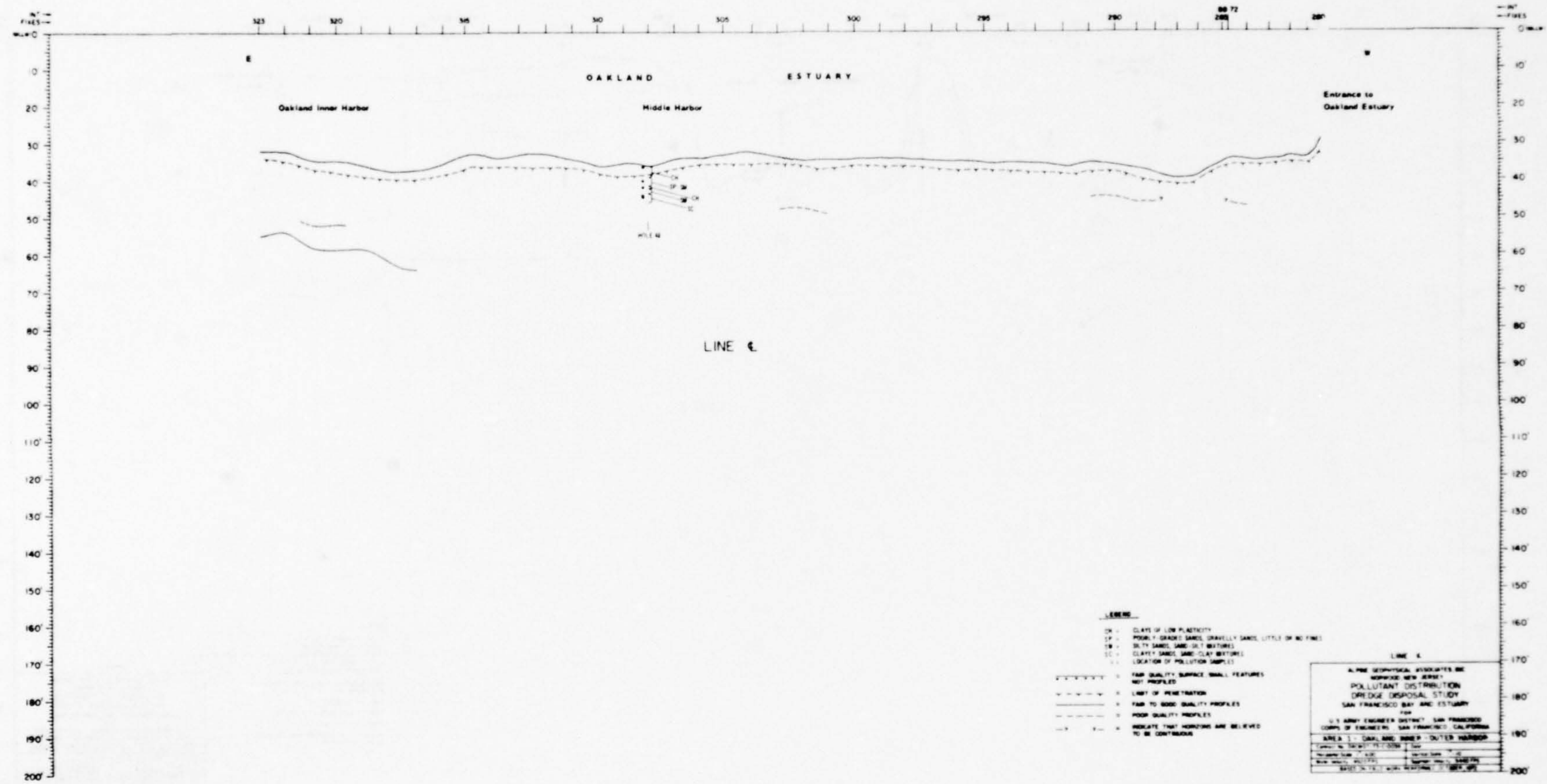

Oakland Outer Harbor
Southern Berkeley Flats
Treasure Island
to West
San Francisco—Oakland Bay Bridge
LINE A
LINE A
LEGEND
FAIR QUALITY, SURFACE, SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
CH - CLAYS OF LOW PLASTICITY
SC - CLAYEY SANDS, SAND-CLAY MIXTURES
SM - SILTY SANDS, SAND-SILT MIXTURES
LOCATION OF POLLUTION SAMPLES
LINE A
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA I - OAKLAND INNER - OUTER HARBOR

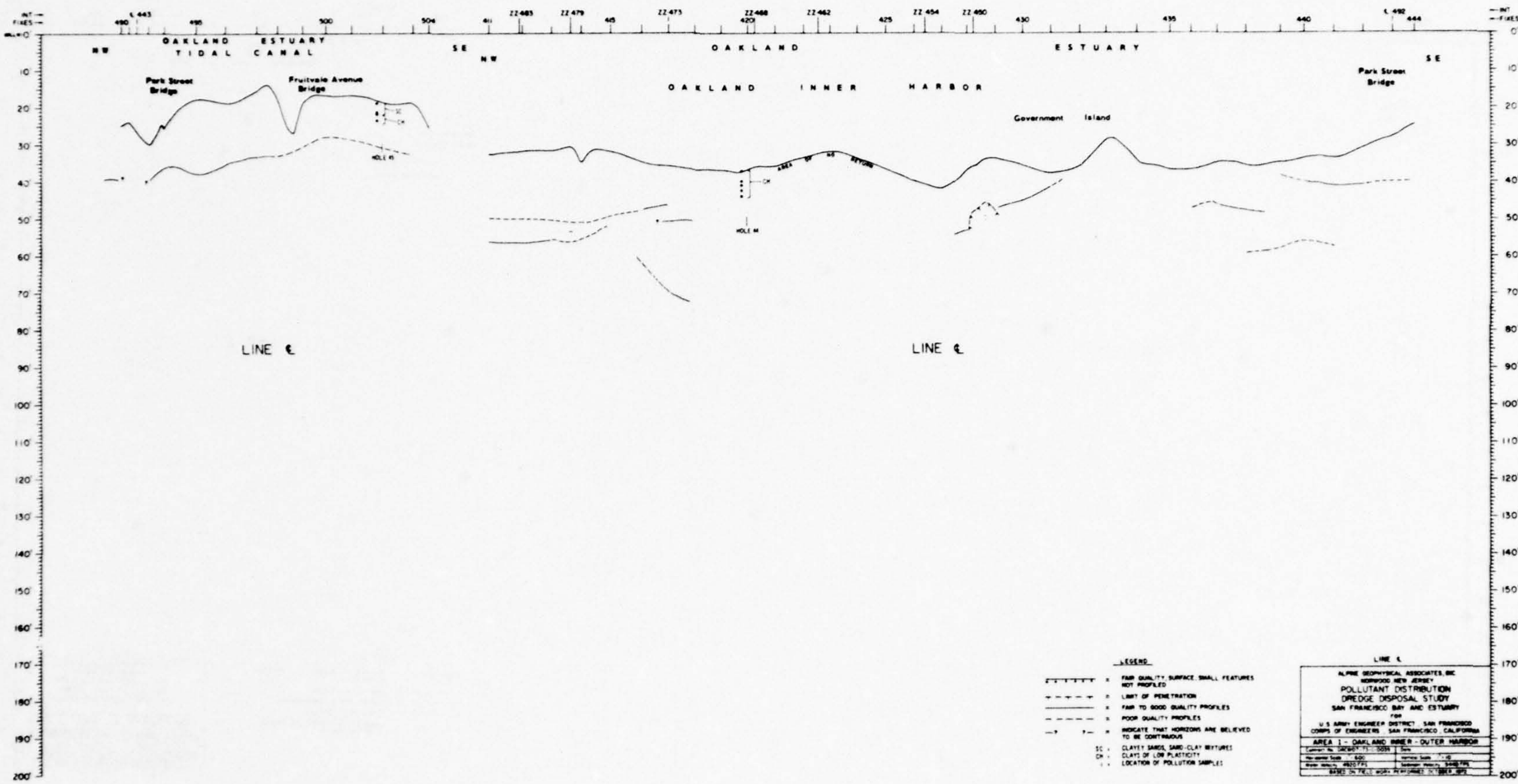

N E
S W
Southern Berkeley Flats
San Francisco—Oakland
Bay Bridge
Oakland Outer Harbor
Entrance Channel
Seventh Street Terminal
Oakland Inner Harbor
Entrance Channel
LINE B
HOLE 37
CH
LEGEND
= FAIR QUALITY, SURFACE SMALL FEATURES NOT PROFILED
= LIMIT OF PENETRATION
= FAIR TO GOOD QUALITY PROFILES
= POOR QUALITY PROFILES
= INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
CH = CLAYS OF LOW PLASTICITY
= LOCATION OF POLLUTION SAMPLES
LINE B
ALPINE GEOPHYSICAL ASSOCIATES, INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U S ARMY ENGINEER DISTRICT , SAN FRANCISCO
CORPS OF ENGINEERS , SAN FRANCISCO , CALIFORNIA
AREA 1 - OAKLAND INNER - OUTER HARBOR


South San Francisco Bay
Alameda Naval Air
Station to East
Oakland Inner Harbor Channel
Yerba Buena Island
to NW
Bar Channel to
Oakland Harbor
Oakland Inner Harbor Channel
LINE CC
LINE C
LINE BB
HOLE 31
LEGEND
= FAIR QUALITY, SURFACE SMALL FEATURES NOT PROFILED
= LIMIT OF PENETRATION
= FAIR TO GOOD QUALITY PROFILES
= POOR QUALITY PROFILES
= INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
CH = CLAYS OF LOW PLASTICITY
CL = CLAYS OF LOW TO MEDIUM PLASTICITY, SANDY CLAYS, SILTY CLAYS
= LOCATION OF POLLUTION SAMPLES
LINES CC-C-BB
ALPINE GEOPHYSICAL ASSOCIATES, INC.
NORWOOD, NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA 1 - OAKLAND INNER-OUTER HARBOR


LINE AA
LINE B-REURN
LINE D
Southern Berkeley Flats
Oakland Outer Harbor
N W
S E
N E
S W
CL
CH
SC
SP
HOLE 16
LEGEND
CL = CLAYS OF LOW TO MEDIUM PLASTICITY, SANDY CLAYS, SILTY CLAYS
CH = CLAYS OF LOW PLASTICITY
SC = CLAYEY SANDS, SAND-CLAY MIXTURES
SP = POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
x = LOCATION OF POLLUTION SAMPLES
= FAIR QUALITY, SURFACE SMALL FEATURES NOT PROFILED
= LIMIT OF PENETRATION
= FAIR TO GOOD QUALITY PROFILES
= POOR QUALITY PROFILES
= INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINES AA - B-RERUN - D
ALPINE GEOPHYSICAL ASSOCIATES, INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U S ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA I - OAKLAND INNER - OUTER HARBOR
Horizontal Scale 1":600
Water Velocity 4800 FPS

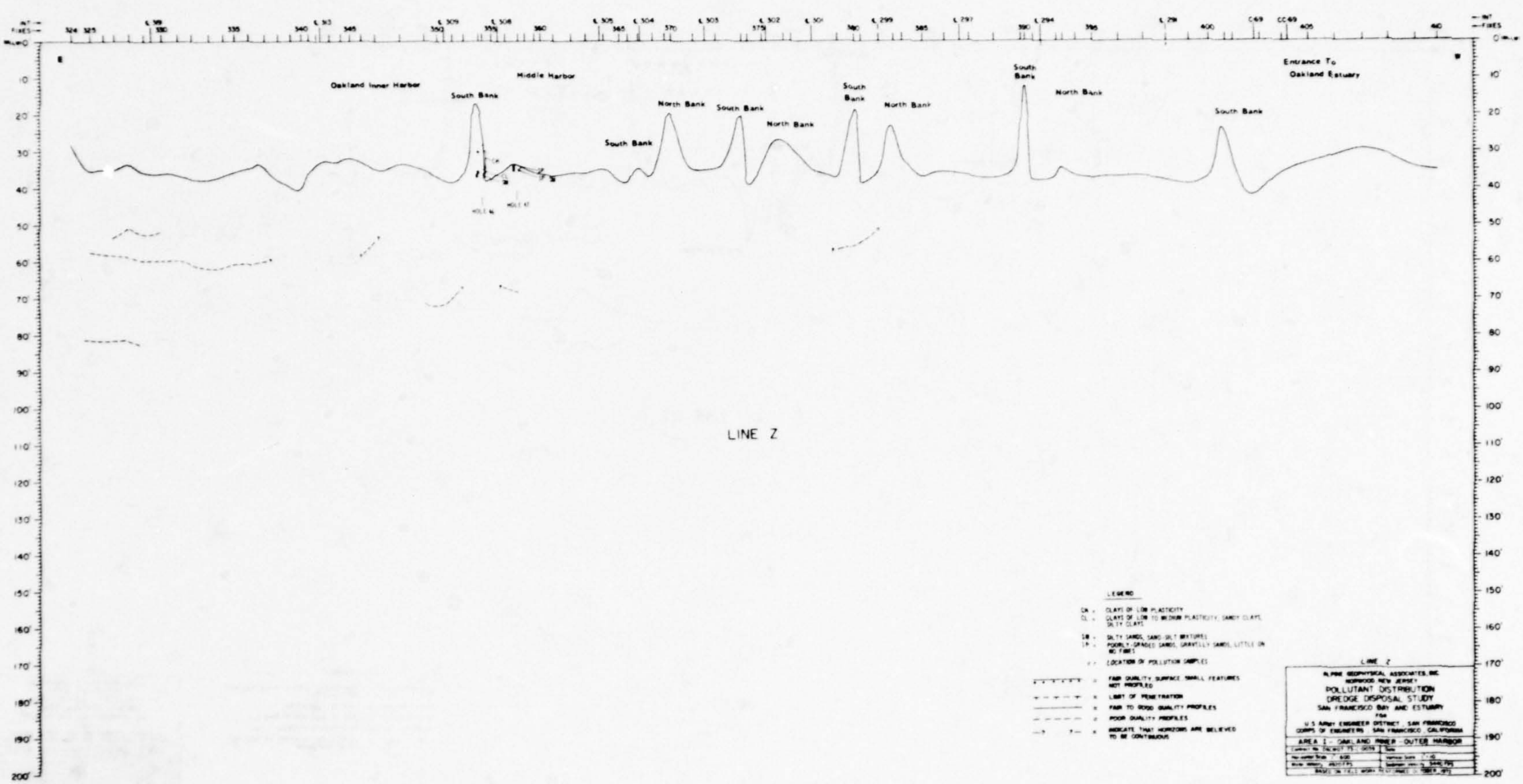

LINE E
Oakland Outer Harbor
Oakland Outer Harbor
Oakland Outer Harbor
TURN
HOLE 41
HOLE 42
LEGEND
CH = CLAYS OF LOW PLASTICITY
SM = SILTY SANDS, SAND-SILT MIXTURES
SP = POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SC = CLAYEY SANDS, SAND-CLAY MIXTURES
LOCATION OF POLLUTION SAMPLES
FAIR QUALITY, SURFACE, SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
ALPINE GEOPHYSICAL ASSOCIATES, INC.
NORWOOD, NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA I - OAKLAND INNER-OUTER HARBOR


E
W
OAKLAND
ESTUARY
Oakland Inner Harbor
Middle Harbor
Entrance to
Oakland Estuary
LINE C
LEGEND
CLAYS OF LOW PLASTICITY
POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SILTY SANDS, SAND-SILT MIXTURES
CLAYEY SANDS, SAND-CLAY MIXTURES
LOCATION OF POLLUTION SAMPLES
FAIR QUALITY SURFACE, SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA 1 - OAKLAND INNER - OUTER HARBOR

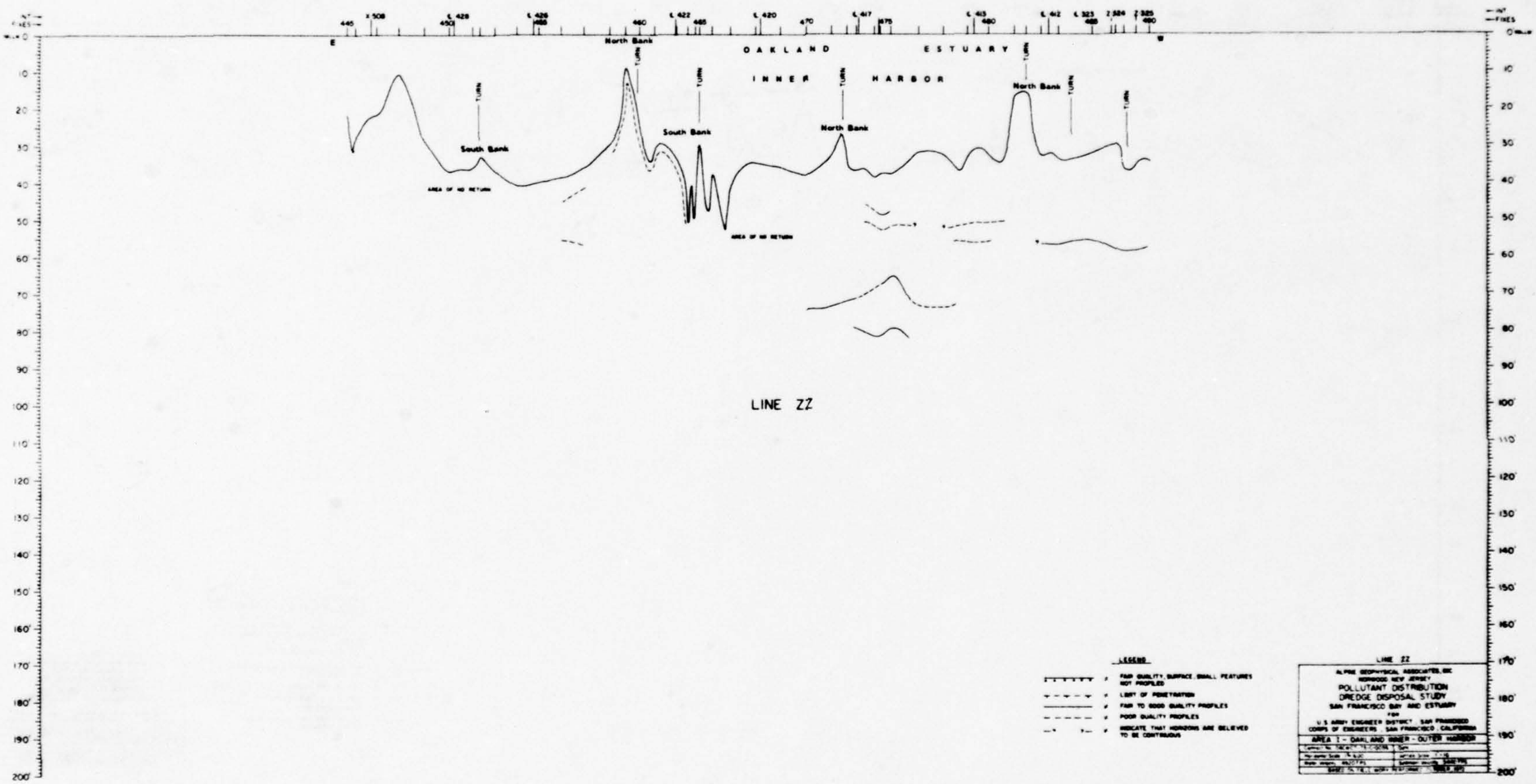


OAKLAND ESTUARY
TIDAL CANAL
NW
SE
Park Street Bridge
Fruitvale Avenue Bridge
HOLE
OAKLAND ESTUARY
OAKLAND INNER HARBOR
Government Island
Park Street Bridge
LINE ℄
LINE ℄
LEGEND
FAIR QUALITY SURFACE, SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
SC - CLAYEY SANDS, SAND-CLAY MIXTURES
CH - CLAYS OF LOW PLASTICITY
LOCATION OF POLLUTION SAMPLES
LINE ℄
ALPINE GEOPHYSICAL ASSOCIATES, INC
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA 1 - OAKLAND INNER - OUTER HARBOR


W
BROOKLYN BASIN
E
Government Island to South
505
22,446
510
520
524
Oakland Inner
Harbor Channel
LINE X
LEGEND
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINE X
ALPINE GEOPHYSICAL ASSOCIATES INC
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA I - OAKLAND INNER - OUTER HARBOR
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200



LINE Z
Oakland Inner Harbor
South Bank
Middle Harbor
South Bank
North Bank
South Bank
North Bank
South Bank
North Bank
South Bank
North Bank
South Bank
Entrance To
Oakland Estuary
LEGEND
CLAYS OF LOW PLASTICITY
CLAYS OF LOW TO MEDIUM PLASTICITY, SANDY CLAYS, SILTY CLAYS
SILTY SANDS, SAND-SILT MIXTURES
POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
LOCATION OF POLLUTION SAMPLES
FAIR QUALITY SURFACE SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
LINE Z
ALPINE GEOPHYSICAL ASSOCIATES, INC.
NORWOOD NEW JERSEY
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
FOR
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS, SAN FRANCISCO, CALIFORNIA
AREA I - OAKLAND INNER - OUTER HARBOR


OAKLAND ESTUARY
INNER HARBOR
North Bank
South Bank
TURN
AREA OF NO RETURN
LINE ZZ
LEGEND
FAIR QUALITY SURFACE, SMALL FEATURES NOT PROFILED
LIMIT OF PENETRATION
FAIR TO GOOD QUALITY PROFILES
POOR QUALITY PROFILES
INDICATE THAT HORIZONS ARE BELIEVED TO BE CONTINUOUS
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY
U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS SAN FRANCISCO, CALIFORNIA
AREA 1 - OAKLAND INNER - OUTER HARBOR

INCLOSURE 3

MARINE SEISMIC REFLECTION PROFILES REPORT

FINAL REPORT

MARINE SEISMIC REFLECTION PROFILES
POLLUTANT DISTRIBUTION
DREDGE DISPOSAL STUDY
SAN FRANCISCO BAY AND ESTUARY

Prepared For

U.S. ARMY ENGINEER DISTRICT
SAN FRANCISCO CORPS OF ENGINEERS

By

ALPINE GEOPHYSICAL ASSOCIATES, INC.
70 Oak Street
Norwood, New Jersey 07648

Submitted by: ______________________
James C. Miller
Project Geophysicist

Approved by: ______________________
George B. Tirey
Vice President

1296

TABLE OF CONTENTS

MARINE SEISMIC REFLECTION PROFILES

POLLUTANT DISTRIBUTION

DREDGE DISPOSAL STUDY

SAN FRANCISCO BAY AND ESTUARY

I. Introduction

The Department of the Army, San Francisco District, Corps of Engineers, contracted with Alpine Geophysical Associates, Inc., of Norwood, New Jersey for the latter to conduct a continuous seismic reflection survey using three independent systems: 1) Sparker, 2) Uni-Boom, 3) 3.5 KHz subbottom profiler, of the following areas:

Area 1 - Oakland Inner-Outer Harbor

Area 2 - San Pablo Straits-Berkeley Flats

Area 3 - San Pablo Bay-Carquinez Straits

The purpose of the continuous seismic reflection survey was, in general, to detect and delineate the subbottom geologic features in the study area. Specifically, the objective of the survey was to delineate and profile within the upper twenty-five feet (25') of the subbottom, the various subbottom reflecting horizons which would serve as a guide in determining the horizontal and vertical distribution of possible pollutants within the study area.

The geophysical project commenced on Monday, October 9, 1972, when the Alpine staff, consisting of an electronics technician and geophysicist traveled from Norwood, New Jersey to San Francisco, California, where the Alpine personnel met with the personnel of Towill, Inc., sub-contractor for navigation and bathymetry.

Mobilization of geophysical instruments and installation of navigational equipment aboard the survey vessel, JACK SALMON, was completed by mid-day, Wednesday, after which test runs were made in the Berkeley Flat area. Geophysical field operations commenced late in the afternoon of Wednesday, October 11, 1972. Field operations continued through Tuesday, October 31, 1972, after which the geophysical and navigational instruments were removed from the vessel and prepared for return shipment. The Alpine staff departed from San Francisco for Norwood on Thursday, November 2, 1972.

II. Description of Equipment

A. Sparker

The Sparker is a source of acoustical energy for marine seismic reflection profiling in which an electrical discharge (spark) in the sea water produces a high level, relatively broad band acoustical impulse. The "spark" is initiated at a fixed repetition rate by a dual channel Alpine Precision Echo Sounding Recorder (PESR), and the reflected energy is detected by a towed hydrophone array (eel) amplified, filtered, and recorded.

The peak acoustical energy produced by the "spark" is approximately one hundred Hertz (100 Hz) with significant energy up to five thousand Hertz (5KHz). The resolution and penetration of the Sparker are dependent upon geological conditions, power and frequency. Instrument settings yielding low power/high frequency provide moderate penetration and high resolution, whereas settings yielding high power/low frequency provide deep penetration with less resolution.

The Sparker consists of the following three subassemblies: 1) Power Supply - Capacitor Bank, 2) High Voltage Switching Unit, and 3) Electrode.

A fifty (50) joule power supply-capacitor bank was used for this project, in order to obtain moderate resolution and penetration to a depth of approximately 250 feet.

The capacitor bank is charged by a high voltage rectifier whose output is continuously variable from 0-10,000 volts. The capacitor bank is connected to the cathode of the air-gap thyratron in the trigger unit; when the trigger unit receives a keying signal from the recorder, the thyratron conducts and the capacitor is discharged through the electrode, producing a pressure wave in the water.

B. Hydrophone Array

The detecting hydrophone array (eel) is composed of ten (10) MP-1 pressure sensitive geophones connected in series-parallel, such that the attenuation for an axially propagated wave is maximum at five hundred Hertz (500 Hz). This arrangement effectively attenuates acoustic signals propagated horizontally along the axis of the hydrophone array, such as ship's noise, while not attenuating vertically propagated signals, such as reflected acoustic waves.

The hydrophones are encased in a pliable plastic tube, sealed at both ends, which is filled with a special non-corrosive fluid, having acoustic properties similar to sea water. The thin cylindrical shape of the eel produces a minimum amount of hydrodynamic tow noise. The tow cable is a two-conductor shielded cable which has sufficient mechanical strength for towing. The complete cable package consists of: 1) hydrophone tow cable, 2) Sparker and electrode cable and 3) a flotation hose to facilitate operation at slow speed and in shallow water.

C. **Pre-Amplifier and Filter**

The signal from the hydrophone array is amplified by a broad band solid state pre-amplifier (Alpine Model 505D) which has a gain of eighty-four decibels (84 db) and a frequency response from ten Hertz (10 Hz) to twelve thousand Hertz (12 KHz) plus or minus three decibels ($\pm$ 3db). The output of the preamplifier is fed to a variable band-pass filter (Krohn-Hite Model 310). The high and low cut-off frequencies of the band pass filter are continuously variable from twenty Hertz (20 Hz) to twenty thousand Hertz (20 KHz). The filter is an active type with an insertion loss of one decibel (1db) within the band pass limits. The attenuation slope is twenty four decibels per octave (24 db/octave) on the low side and twelve decibels per octave (12 db/octave) on the high side. The output of the filter is fed to the input stage of the recorder.

D. Alpine Precision Echo Sounding Recorder (PESR)

The Alpine Precision Echo Sounding Recorder (PESR) is a time sharing recorder, which uses a damp, electro-sensitive paper, eighteen and three-quarters inches (18-3/4") wide. The paper passes between the writing blade and a revolving helix and advances approximately one writing blade width per helix revolution (sweep) or ninety-six (96) lines per inch.

The helix drive motor of the hysteresis type, is supplied by a tuning fork oscillator and associated amplifier which has an accuracy of plus or minus twenty parts per million ($\pm$ 20 PPM). As the contact point between the writing blade and helix move across the paper, the paper is darkened in proportion to the applied voltage. The paper has a dynamic range from white to black of twenty-two decibels (22 db).

When the helix is at the left hand edge of the paper, source "A" (Sparker) is keyed by a photoelectric switch connected to the helix shaft. At the same time print amplifiers are switched such that only

the "A" channel input signal reaches the writing blade. When the helix has completed approximately two-thirds (2/3)[1] of a revolution, the source "B" (Uni-boom) is keyed and print amplifiers are simultaneously switched so that only the "B" channel input signal reaches the writing blade.

Maximum possible penetration of the acoustic signal is controlled by the setting of the helix speed. When the helix speed is set at one-quarter second per revolution (1/4 sec/sweep), channel "A" has a depth range of approximately four hundred feet (400') while channel "B" has a depth range of approximately two hundred feet (200'). These depth ranges are based on a velocity in sea water of forty nine hundred twenty feet per second (4920'/sec). In practice, full scale depth ranges are greater due to the faster velocity of sound in sedimentary material.

E. E.G. & G. Uni-Boom

The E.G. & G. Uni-Boom, an abbreviated name for Unit Pulse Boomer, consists of a transducer mounted on a catamaran float, a capacitor bank and power supply. The transducer produces a single acoustic pulse each time it is fired. It operates on the principle that a moving magnetic field produces eddy currents in a non-magnetic, conducting plate, resulting in an opposing magnetic field which causes the plate to move violently away from the coil, thus producing a pressure pulse in the water. The magnetic field in the Uni-Boom transducer is generated by discharging the capacitors through the coil of the transducer. The plate movement is coupled to the water through a rubber diaphragm and generates an acoustic pulse. The

---

[1] The position of the helix, when the second source is keyed is variable. Normal operation is 2/3 of the record for Channel A and 1/3 for Channel B.

catamaran float provides a stable platform which properly positions the transducer with respect to the water/air interface. The Uni-Boom was operated throughout the survey at a repetition rate of one-quarter of a second.

G. 3.5 KHz Subbottom Profiler

The 3.5 KHz Subbottom Profiler, like the Sparker and Uni-Boom systems, is a continuous seismic reflection profiler, with the specialized capacity of high resolution of shallow stratified layers within the top fifty feet of the subbottom. Although the instrument is commonly referred to as a 3.5 KHz unit, both the transducer array and transceiver are variable frequency units having a range between 3.5 KHz and 7.0 KHz. A frequency setting of 5.1 KHz was used for this survey.

The recording unit for the transducer-transceiver system is an Alpine/Alden model 469 operating at a sweep rate of one-twentieth of a second. This fast sweep rate is rather unique in that it separates subbottom reflections and makes highly resolved reflections more readily recognizable.

The transducer array is mounted on the side of the vessel and is capable of clear recordings at relatively fast survey speeds.

III. Navigation and Bathymetry

Navigation and bathymetry control were supplied by Towill, Inc. of San Francisco, California.

The navigation system, Hydro-Plotter, is a range-azimuth system with an accuracy of 10', consisting of a shore master station and a

remote/slave station aboard the ship. The shore station maintained a track of the vessel's position by plotting the vessel's position each minute. Compensating navigational correction, necessary to maintain track lines, were given to the vessel from the shore station.

Bathymetric control was obtained by means of a precision bathymetric recorder. The bathymetric records were correct to mean lower low water through the use of tide gauges. The bathymetric recorder is accurate less than one half foot.

IV. Survey Vessel

The survey vessel, JACK SALMON, is a forty-three foot, steel hull, twin screw, party fishing boat. Figure 1 is a sketch of the vessel showing the placement of the geophysical and navigational equipment. With the exception of the hydro-plotter remote transceiver, all of the electronic equipment was located in the vessel's wheelhouse/cabin. The vessel was normally operated, depending upon ambient noise conditions, at speeds between three (3) and five (5) knots.

Power for the geophysical instruments was supplied by two (2) 3.8 KW portable generators located on the after deck of the vessel. Power for the bathymetric and navigational equipment was supplied by lead-acid storage batteries.

V. Theory of Continuous Seismic Profiling

The seismic reflection method utilizes the fact that geologic discontinuities are usually associated with a change in the acoustical

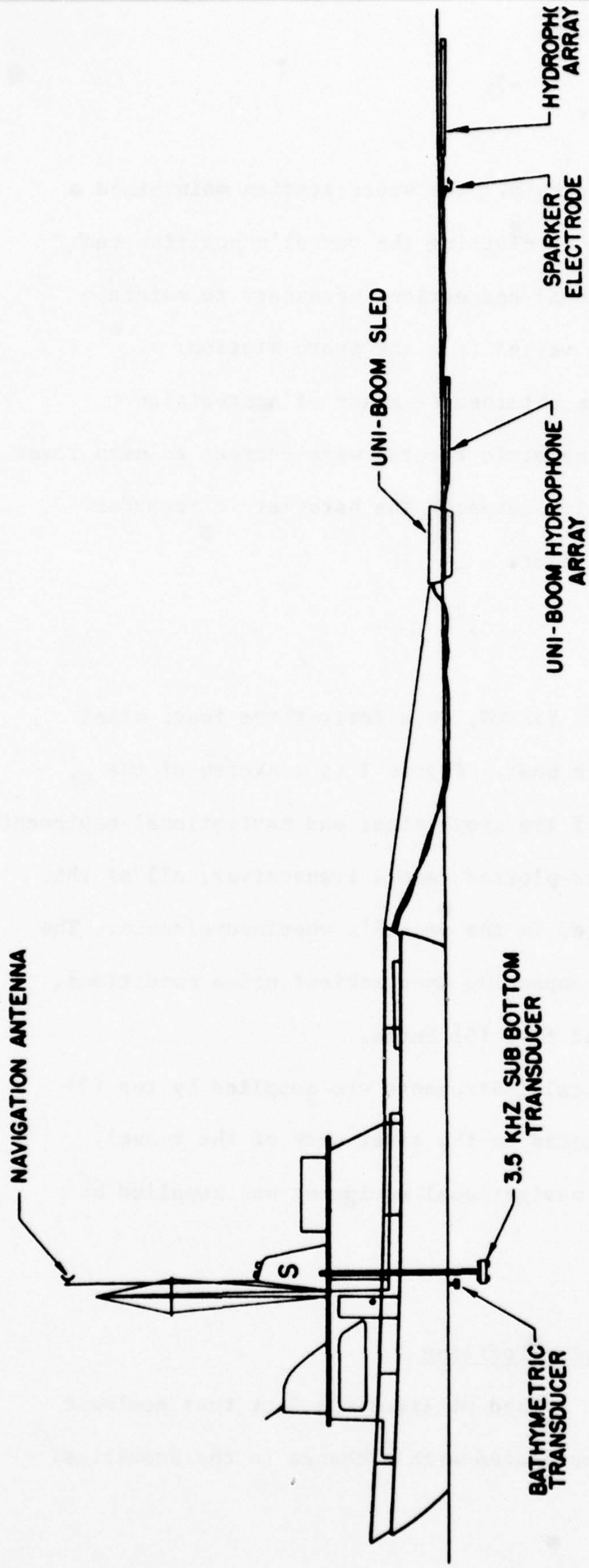

NAVIGATION ANTENNA
S
3.5 KHZ SUB BOTTOM TRANSDUCER
BATHYMETRIC TRANSDUCER
UNI-BOOM SLED
UNI-BOOM HYDROPHONE ARRAY
SPARKER ELECTRODE
HYDROPH
ARRAY

FIGURE I

properties of the transmitting medium. The change may represent a real discontinuity or it may be a zone of very rapid change in acoustical properties. The physical condition causing the change in acoustical properties between two sediments may or may not be related to the lithology, although reflecting interfaces are usually indicative of a change in the sediment types. Changes in sediment densities or water content within a sediment layer may produce a reflecting interface although there is no variation in the sedimentary material.

The amount of acoustic energy reflected from an interface separating two different sedimentary strata is proportional to their acoustic impedances. The acoustic impedance is expressed mathematically by the following equation:

$Z = PV$ where P is the density, and V is the velocity of the compressional wave through the mediym. The ratio of reflected energy to incident energy at the interface is related to acoustic impedance of the two media by the following equation:

$$\frac{E_r}{E_i} = \frac{(P_2V_2 - P_1V_1)^2}{(P_2V_2 + P_1V_1)^2}$$

For normal incidence where subscripts 1 and 2 refer to different media.

Thus, the amount of reflected energy depends upon the contrast in both the densities and velocities of sound in the respective layers.

The sound energy in an ideal homogeneous medium would propagate from a sound source as a spreading spherical wave. The acoustic energy arriving at any point in the medium would be proportional to the inverse square of the distance from the source. However, attenuation processes are also related to the physical characteristics of the transmitting medium. Thus, such factors as absorption, dispersion, scattering and

diffraction effect losses in acoustic wave propagation. Attenuation losses are generally frequency dependent, such that higher frequencies attenuate faster than lower frequencies.

VI. Interpretation of Geophysical Data

A. Continuous Reflection Profiles

The interpretation of continuous reflection profiles is straightforward and does not require the reading of multiple trace (single-fold) or the compositing of records (multi-fold) as with conventional marine seismic surveys. The continuous profile record is recognized as a continuous profile of the water column, ocean bottom, and geological layering in the subbottom. Figures 2 and 3 are sample continuous profile records.

B. Vertical Scale

Since a continuous seismic reflection profile is a recording of vertical travel time, and since, in most applications, the depth to a horizon rather than its travel time is desired, a conversion must be made from time to depth, and since it is desirable to know the depth of each horizon below a datum, mean lower low water, the recorded reflection signals must be corrected to the datum plane and converted to depth. Correction to a datum plane is accomplished through the use of a precision depth (bathymetric) recorder and tide gauges. Profiles of the bottom referenced to MLLW were constructed from the bathymetric recordings. In order to convert the continuous reflection profiles from time to depth, knowledge of the velocity of acoustic waves (sound) in the sediments is necessary. Since continuous reflection profiles give no information about the velocity,

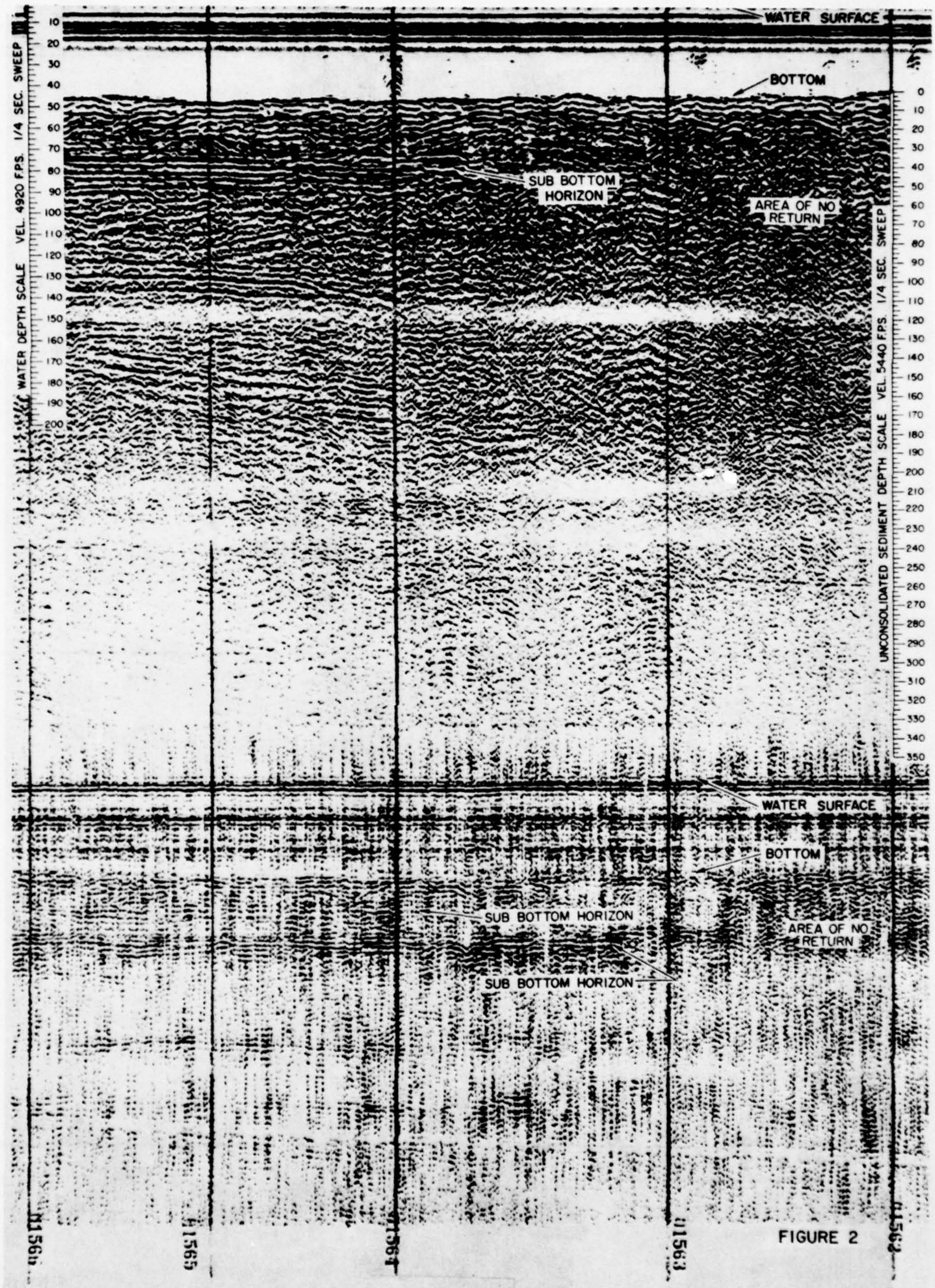

WATER SURFACE
BOTTOM
SUB BOTTOM HORIZON
AREA OF NO RETURN
WATER DEPTH SCALE VEL. 4920 F.P.S. 1/4 SEC. SWEEP
UNCONSOLIDATED SEDIMENT DEPTH SCALE VEL. 5440 F.P.S. 1/4 SEC. SWEEP
WATER SURFACE
BOTTOM
SUB BOTTOM HORIZON
AREA OF NO RETURN
SUB BOTTOM HORIZON
11566
11565
11564
11563
11562

FIGURE 2

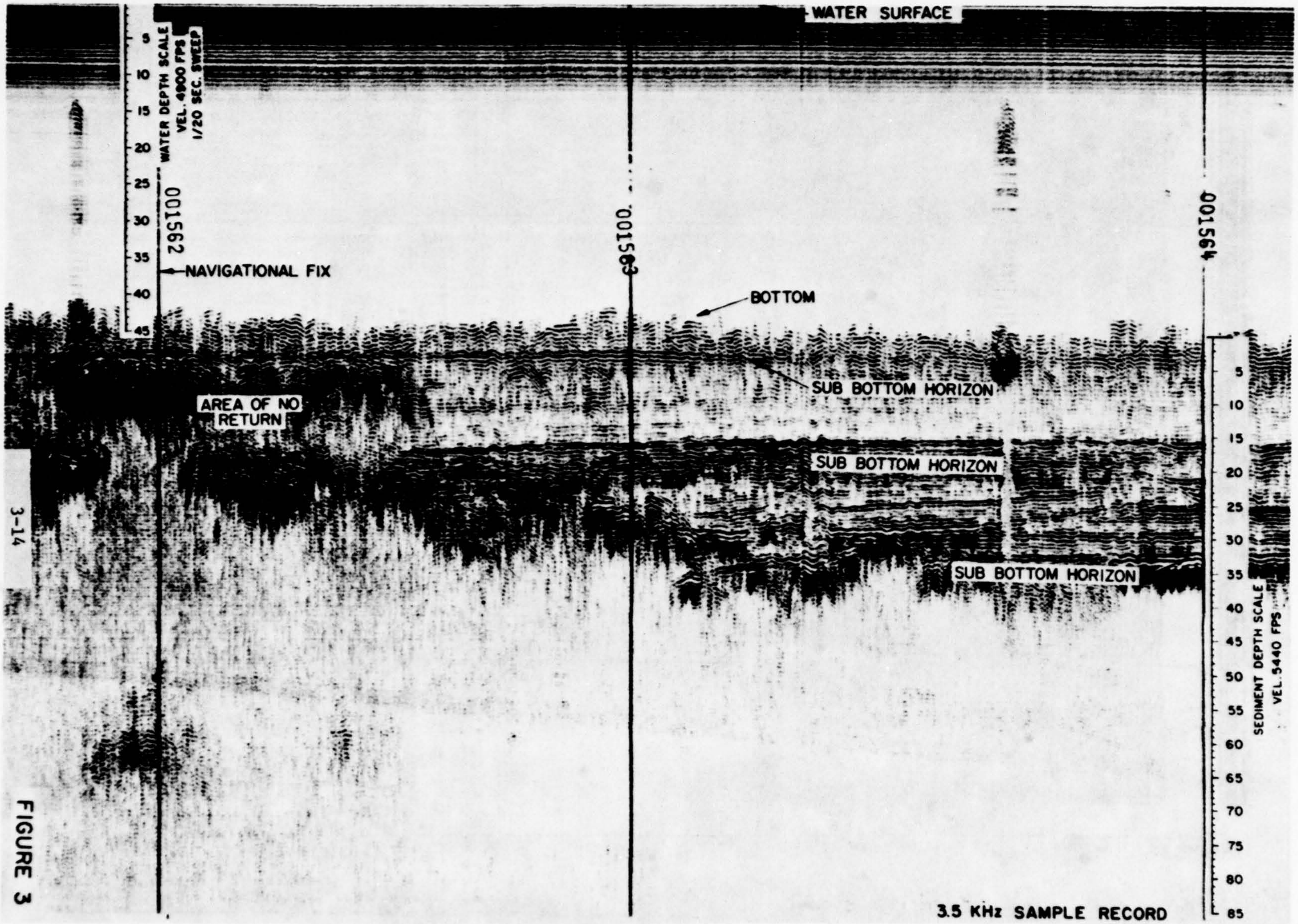

WATER SURFACE
WATER DEPTH SCALE
VEL. 4900 FPS
1/20 SEC. SWEEP
5 10 15 20 25 30 35 40 45
001562
NAVIGATIONAL FIX
001563
001564
BOTTOM
SUB BOTTOM HORIZON
AREA OF NO RETURN
SUB BOTTOM HORIZON
SUB BOTTOM HORIZON
SEDIMENT DEPTH SCALE
VEL. 5440 FPS
5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85
3.5 KHz SAMPLE RECORD

FIGURE 3

it must be determined independently. A velocity of 5440'/sec has been used for other work in the area, and is a typical velocity for unconsolidated sediments. This is an "average" velocity, but because of the wide variety of conditions that may be found in the survey area, the following type of errors may be present:

1. If localized "lenses" of higher or lower velocity material are present, flat surfaces below the "lenses" will be interpreted as anticlines or synclines respectively.

2. If the velocity in the sediments is different by uniform factor, the shape of structures will be correct, but their depth will be in error by a constant factor.

Knowing the velocity and the sweep rate of the recorder, it is possible to construct a depth scale for use with the records. Figure 4 shows the scales used for the PESR and Alden recorder.

C. Navigational Fixes and Horizontal Scale

Since the recording systems used operate on a time base in both x (horizontal) and y (vertical) axis, there is no horizontal scale which can be applied directly to the field records. Horizontal scaling is accomplished by recording "fix" marks at one minute intervals. The fix mark records the location of the navigational antenna, and assuming the speed of the vessel to be constant between fixes, the location of any "event" can be determined through linear interpolation. Since the receiving elements of the seismic systems are not at the same point as the navigational antenna, the fix mark as recorded on the PESR and Alden Recorder does not mark the same location. The 3.5 Kc transducer was mounted in the same plane as the navigational antenna while the Uni-Boom transducer and eel

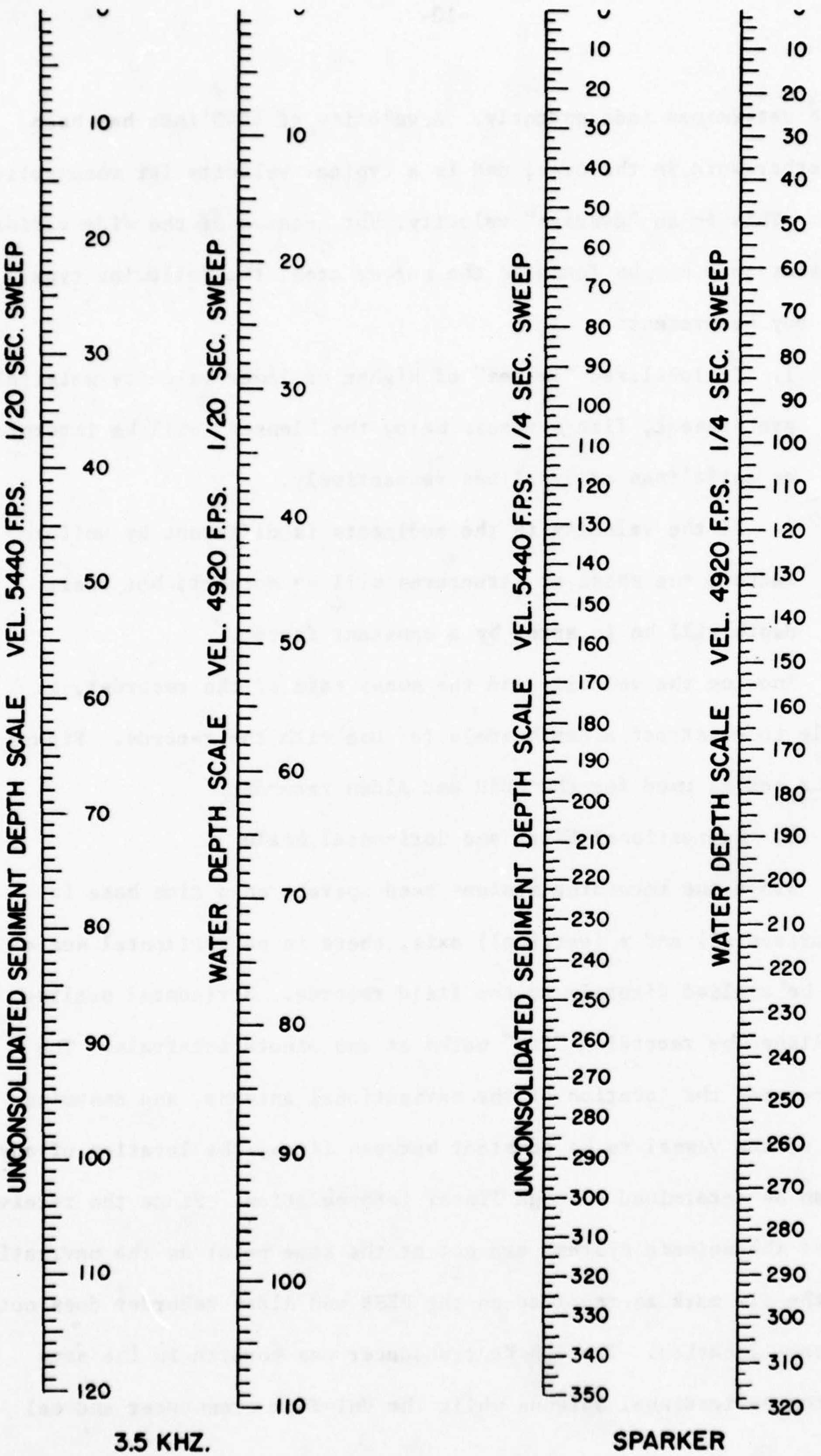

UNCONSOLIDATED SEDIMENT DEPTH SCALE VEL. 5440 F.P.S. 1/20 SEC. SWEEP
WATER DEPTH SCALE VEL. 4920 F.P.S. 1/20 SEC. SWEEP
UNCONSOLIDATED SEDIMENT DEPTH SCALE VEL. 5440 F.P.S. 1/4 SEC. SWEEP
WATER DEPTH SCALE VEL. 4920 F.P.S. 1/4 SEC. SWEEP
3.5 KHZ.
SPARKER

FIGURE 4

were located fifty feet aft of the antenna, and the Sparker eel was one hundred seventy feet aft. In plotting the data on the profile sheets, the event at the fix mark, in the case of the Uni-Boom and Sparker, was moved fifty and one hundred seventy feet towards the previous fix respectively, while the event on the 3.5 Kc transceiver was plotted at the fix location.

D. Multiple Reflections

Although the interpretation of the records is normally straightforward, the occurrence of multiple reflections on the records make the interpretation sometimes difficult. Multiples, or multiple reflections, are due to the reverberating effect of the sound between the bottom or subbottom layers and the water surface. Such repeated reflections may obscure the record to the point that the first reflected arrival from a subbottom horizon is either missed or confused with the multiple reflection. This condition was encountered in only a few areas of the survey, and for the most part presented no serious problem to the interpretation of the Sparker records.

VII. Field Procedures

A. Scope of Work

The objective of the seismic study is to delineate and map various subbottom reflecting horizons which may be a guide for determining the horizontal and vertical distribution of pollutants within a project area. The government intends to use the data as a guide for obtaining core samples at frequent intervals along the lines of profiles, to compare these samples with results of the seismic reflection profile charts, and to test the core sample materials for pollutant content. Although core sampling was excluded from this scope of services, recommendations derived from the

geophysical data for a future core sampling program are included in this report.

B. Geophysical Routines

Each day upon leaving the dock the fathometer was calibrated by use of a lead line with metal disc, the geophysical equipment was put over the stern and the vessel proceeded to a point of known range to be picked up by the navigation system. At the end of the day the geophysical equipment was brought aboard and the fathometer again calibrated.

VIII. Presentation of Data

A. Navigational Plan Map

The field navigational plan maps, which show the track of the vessel as dots annoted by fix numbers, were plotted at the shore station during field operations. These maps were replotted to a scale of 1" = 600' and professionally drafted by personnel of Towill, Inc. The final navigational maps are included in the appendix with their respective profiles.

B. Seismic Profiles

The seismic profiles included in the appendix represent the geophysicist's interpretation of the seismic reflection data. The profiles are plotted to a horizontal scale of 1" = 600', conforming to the scale of the navigational maps, and to a vertical scale of 1" = 10'. The profiles constructed with a vertical exaggeration of 60:1 do give an inaccurate representation of stratification. The true angle of dip is determined by a tangent relationship rather than by a simple angular division by 60. Further complicating the evaluation of the dips is the fact that the systems used are in general omni-directional, and, therefore, measure the shortest path from source to reflector to receiver. For a dipping bed this path

is the normal incident path and will be updip from the position of the source. For small angles of dip the error generated is small, for large angles of dip (apparent true dip greater than 10°), the error is significant. This error can be corrected for by migrating the data back to its correct origin. Migration was not applied to the data presented in this report since dip angles were small.

Due to the vertical exaggeration, it was necessary to present as smooth surfaces some irregular surfaces where the horizontal extent of the irregularity was less than fifty feet. An effort was made to show irregular features where their horizontal extent was large. The profiles of both bottom and subbottom represent a smooth curve fit of the data points.

The seismic profiles presented represent major continuous horizons. Where no continuous horizons were present but bedding planes indicated, small discontinuous sections were profiled.

Since it is believed that the no-data areas will be of significance, a "horizon" which represents the limit of penetrations has been profiled. The limit of penetration was based on a subjective analysis of the data. In general, the limit of penetration was associated with what was believed to be gaseous layers within the near-surface sediments often indicative of a high organic content. A sample of field record (Figure 5) shows the limit of penetration and demonstrates that the limit of penetration effect was caused by the materials in the near surface sediments. It should be noted that subsurface horizons become recognizable in places where a channel has been cut through the surface sediments.

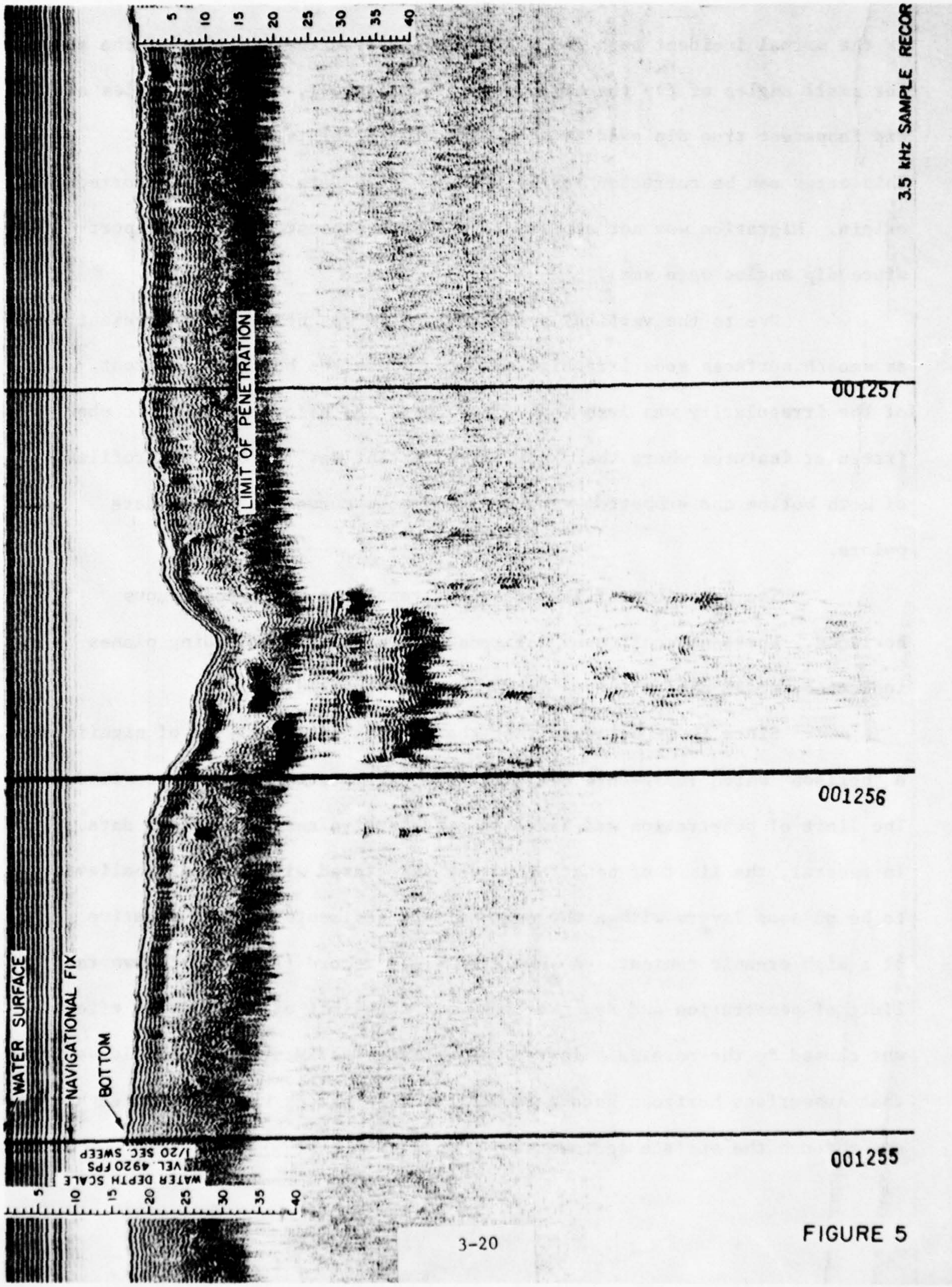

3.5 kHz SAMPLE RECOR
WATER SURFACE
NAVIGATIONAL FIX
BOTTOM
LIMIT OF PENETRATION
001257
001256
001255
WATER DEPTH SCALE
VEL. 4920 FPS
1/20 SEC. SWEEP
5
10
15
20
25
30
35
40

FIGURE 5

A second form of "no data" area is characterized by a lack of any coherent return. Such areas are noted as no data areas on the profile.

Examination of the field data shows that weak returns, usually parallel to either the bottom or the horizons profiled, do appear on the records. It will be impossible, however, to classify these returns until a coring program has been completed. The most likely causes of these weak returns are; 1) changes in the water content, 2) small density changes, 3) inter-bedding, 4) elastic response of the boundary above, or 5) actual geological horizons.

When the profile of intersecting lines are compared, possible lack of correlation in depth of some weak horizon may be found. It is possible to profile a horizon on any of several "legs", the "legs" resulting from ringing in the source and the elastic properties of the sediments. Each "leg" is a wavelength deeper, and with weak reflectors it is relatively easy to jump "legs".

IX. Discussion of Data

A. Generalized Geology of San Francisco Bay

The formations of interest for this study are of Pleistocene or younger age. During this time period the Bay has acted as a settling basin for material brought in by the Sacramento and San Joaquin Rivers to the north and by local streams to the south. Deltaic deposits of sand formed near the mouths of the rivers and streams. Away from the mouths of the river and streams the deltaic sand deposits are found to be interfingered with clay deposits. This process has been repeated during each high stand of sea level. During the low stands these sediments have been

exposed and subjected to erosion. Because of the exposure of the sediments, the Pleistocene clays (older bay muds) have become over-consolidated. The older bay muds range in thickness from 0 to 200 feet.

Deposition resumed with the end of the last glaciation and the associated rise in sea level. These younger holocene clay deposits, known as the younger bay muds, are found in deposits up to seventy feet thick.

B. Area I - Oakland Inner-Outer Harbor

The data from Area I varies in quality from good to poor, the best data being obtained from the area off Yerba Buena and Treasure Islands where penetration exceed 100 feet, and the poorest from the inner harbor channel where areas of no data existed. Figure 6 is a map showing the proposed track lines and indicating the approximate limits of the good data.

The data obtained in the vicinity of Yerba Buena Island indicates several possible outcrops. The data from the Inner Harbor Channel shows several areas of no data, usually of the limit of penetration type. Where penetration was achieved the data indicates the subbottom to consist of several moderately thick (approximately 10') generally flat lying layers overlaying a layer with moderate relief. No evidence of faulting was noted within the area.

C. Area II - San Pablo Straits-Berkeley Flats

The data from Area II, as in the other areas, varied from good to poor. There were significant areas of no penetration, and in an effort to better define one such area, approximately nineteen miles of track line were laid out and run (lines B-1 through B-14).

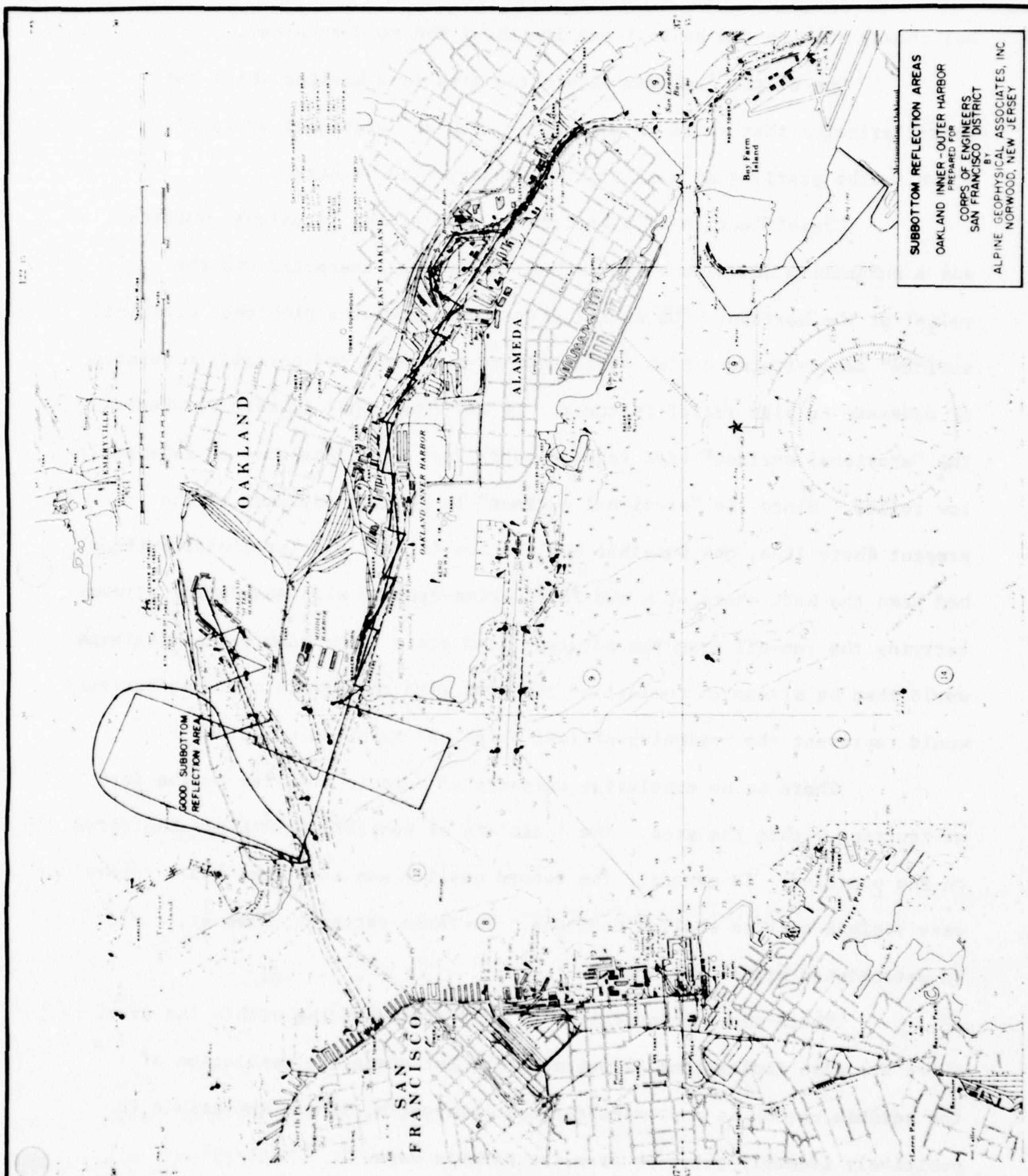

SUBBOTTOM REFLECTION AREAS
OAKLAND INNER-OUTER HARBOR
PREPARED FOR
CORPS OF ENGINEERS
SAN FRANCISCO DISTRICT
BY
ALPINE GEOPHYSICAL ASSOCIATES, INC
NORWOOD, NEW JERSEY
GOOD SUBBOTTOM REFLECTION AREA
OAKLAND
EAST OAKLAND
ALAMEDA
OAKLAND INNER HARBOR
EMERYVILLE
SAN FRANCISCO
Bay Farm Island

FIGURE 6

Figure 7 is a map of the proposed track lines (lines B-1 through B-1 not shown) showing the approximate limits of the no data areas.

One of the features within the area is a horizon which has characteristics that would be associated with an "erosional surface", shown on the profiles as a solid line, underscored by dots.

Classification of a horizon as part of the "erosional surface" was a subjective decision based on both the signal character and the relief at the horizon. The signal character associated with the "erosional surface" demonstrated a high reflection co-efficient and normally consisted of moderate to high relief features. It was found that in several places the "erosional surface" tied together with flat lying horizons of relatively low relief. Since the "erosional surface" is located adjacent to the present shore line, one possible explanation is that the "erosional surface" had been the back shore of a mud flat, criss-crossed with meandering streams carrying the run-off from the adjacent land areas. The high relief features would then be stream channels, and the ties with the smooth surfaced horizons would represent the beginning of land which had remained submerged.

There is no conclusive evidence of seismic activity in the form of faulting within the area. The locations of possible faults are indicated on the profiles. In general, the record quality was such that fault throws were visible only on shallow horizons. No fault patterns, however, could be established within the area.

There is some indication of sand cross-bedding within the area. There are also indications of outcropping, but since the resolution of the seismic method is approximately one wavelength, it was impossible to positively identify outcrops from the seismic data.

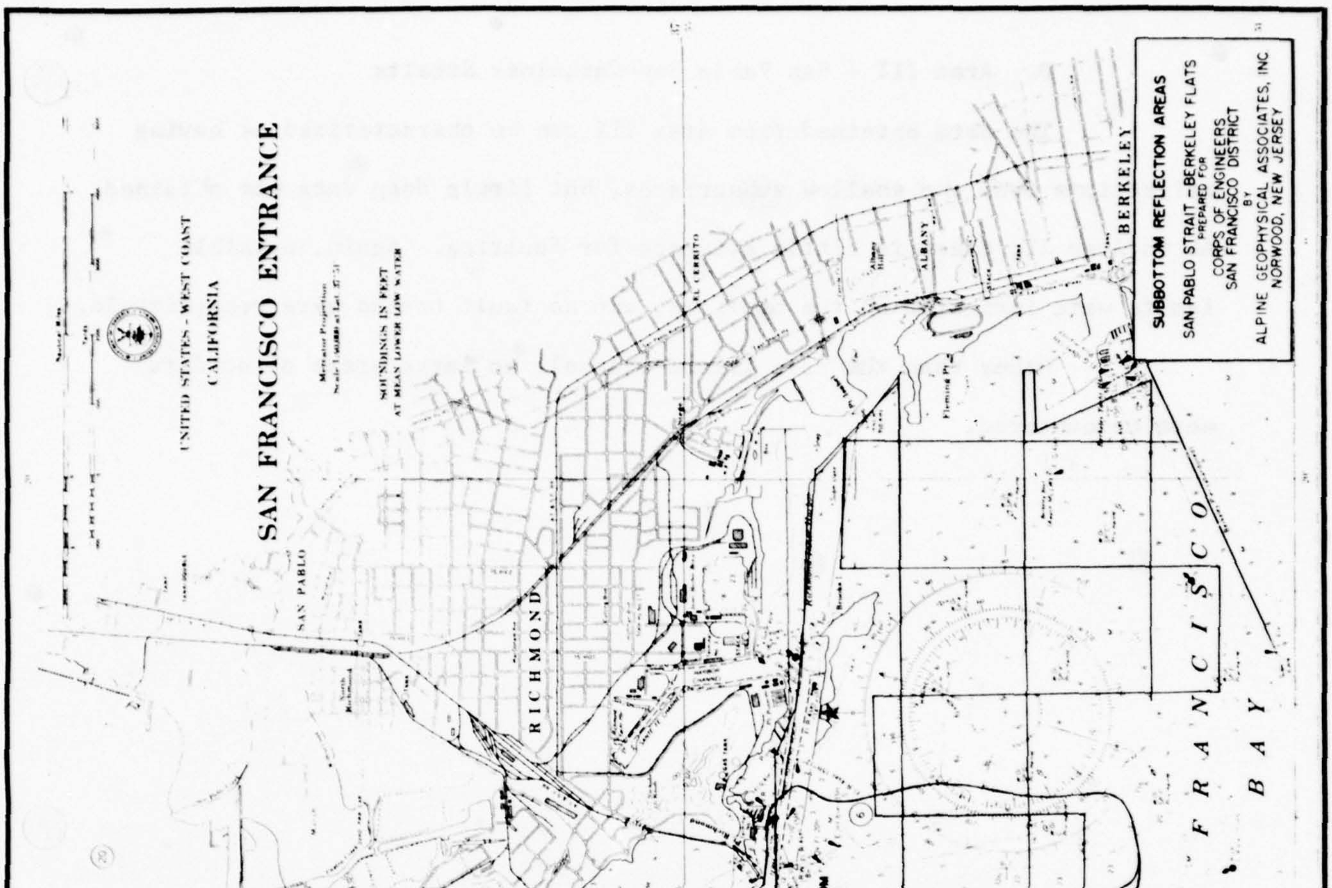

UNITED STATES - WEST COAST
CALIFORNIA
SAN FRANCISCO ENTRANCE
SOUNDINGS IN FEET AT MEAN LOWER LOW WATER
SUBBOTTOM REFLECTION AREAS
SAN PABLO STRAIT - BERKELEY FLATS
PREPARED FOR
CORPS OF ENGINEERS
SAN FRANCISCO DISTRICT
BY
ALPINE GEOPHYSICAL ASSOCIATES, INC
NORWOOD, NEW JERSEY
SAN PABLO
RICHMOND
ALBANY
BERKELEY
SAN PABLO STRAIT
LIMITED SUBBOTTOM REFLECTION AREA
APPROXIMATE LIMIT
LIMITED SUBBOTTOM REFLECTION AREA
APPROXIMATE - LIMIT
LIMITED SUBBOTTOM REFLECTION AREA
SOUTHAMPTON SHOAL
SAN FRANCISCO BAY
TIBURON PENINSULA
ANGEL ISLAND
RACCOON STRAIT
RICHARDSON BAY

FIGURE 7

D. Area III - San Pablo Bay-Carquinez Straits

The data obtained from Area III can be characterized as having reflections from the shallow subsurfaces, but little deep data was obtained. As in Area II, there is little evidence for faulting. Again, possible faults were indicated on the profiles, and no fault trends were recognizable.

Other than the Mare Island Channel, no large areas of no data were encountered.

APPENDIX 1

RECOMMENDATION FOR CORING PROGRAM

Recommendation for Coring Program

The following sites are recommended for coring in order to supplement and enhance the seismic data. Except where noted otherwise, core locations were selected on the basis of providing data which will help tie the seismic data together and give useful information about the horizontal and vertical distribution of possible pollutants in the sediments.

AREA I - Oakland - Inner-Outer Harbor

Line Number	Fix Number	Comments
A	101	Provide data for correlation
A	127	Provide data for correlation
AA	140	Provide data for correlation
B	26	Provide data below 20' and test possible organic horizon
B	158-3/4	Test possible outcrop and provide data below 20' for correlation, test possible organic horizon
BB	79	Test possible anticline feature and provide data for correlation
C	63	Test horizons below 20' and data for correlation
CC	39	Provide data for correlation
D	175	Provide data for correlation
E	198	Provide data for correlation
E	227	Provide data for correlation
E	201	Test poor data area
E	213	Test poor data area
Center Line	420	Test area of no return
Center Line	502	Provide data for correlation

AREA II - San Pablo Straits - Berkeley Flats

Line Number	Fix Number	Comments
A	1379	Test no data area
A	1419	Test no data area
AA	1170	Provide data for correlation
B	1219	Provide data for correlation
BB	721	Test possible fault
BB	728	Test possible fault
C	1278	Provide data for correlation
CC	786	Test no data area
D	294	Test no data area
F	1071	Provide data for correlation
F	633	Test no data area
F	675	Provide data for correlation
FF	1339	Test no data area
FF	375	Provide data for correlation
G	756	Provide data for correlation
G	926	Test possible sand
GG	520	Provide data for correlation
H	984	Provide data for correlation
H	481	Provide data for correlation
J	460	Provide data for correlation
J	410	Test no data area
JJ	1259	Test no data area
JJ	593	Test no data area

AREA II (Cont'd)

Line Number	Fix Number	Comments
K	897	Provide data for correlation
KK	259	Test no data area
XX	926	Provide data for correlation
B-2	1565	Provide shallow data for correlation and test no data area
B-5	1488	Test possible outcrops and no data area
B-7	1448	Provide data for correlation
B-8	1625	Provide data for correlation
B-11	1701	Provide data for correlation

AREA III - San Pablo Bay - Carquinez Straits

A	902	Test no data area
A	860	Test horizons below 10'
B	760	Provide data for correlation
B	778	Test possible fault
C	402	Provide data for correlation
C	808	Test no data area
CC	939	Provide data for correlation
D	342	Test no data area
DD	358	Provide data for correlation
E	278	Provide data for correlation
EE	300	Provide data for correlation
F	84	Provide data for correlation
G	57	Provide data for correlation

AREA III (Cont'd)

Line Number	Fix Number	Comments
GG	1033	Provide data for correlation
H	115	Provide data for correlation
HH	1072	Provide data for correlation
J	135	Provide data for correlation
JJ	1183	Test limit of penetration
N	1167	Provide data for correlation
P	1200	Test horizon below 10'
Center Line	190	Test possible fault
Center Line	193	Test possible fault
Center Line	1134	Provide data for correlation

APPENDIX 2

DAILY LOG OF ACTIVITIES

DAILY LOG

San Francisco Bay & Estuary Study
U.S. Army Corps of Engineers

Monday 9 October, 1972

1200 hrs.	Arrived San Francisco Airport
1300 hrs.	Met with Towill personnel
1345 hrs.	Check on air shipments
1455 hrs.	Picked up TWA shipment and truck transported to Towill office
1600 hrs.	Checked into motel
1630 hrs.	Verified arrival of second shipment

Tuesday 10 October, 1972

0800 hrs.	Picked up second shipment at airport. Truck transported to Towill, Inc. office, loaded first shipment and truck transported to survey vessel, JACK SALMON, located at Merritt Ship Repair, Oakland, Calif. Alpine's Electronic Technician began installation of geophysical instruments while Towill personnel began installation of navigational & bathymetric equipment
1000 hrs.	Meeting with Corps of Engineers
1700 hrs.	Vessel departed Oakland for Berkeley Marina

Wednesday 11 October, 1972 Area: Berkeley

0745 hrs.	Continued installation of instruments & at dock testing, unloaded shipping crates for storage
1300 hrs.	Fueled vessel
1330 hrs.	Departed Berkeley Marina. Operational test of instruments and navigational system.
1730 hrs.	Arrived Berkely Marina

Aboard Vessel:

ALPINE: George B. Tirey
James C. Miller
Bruce Manuel

TOWILL: Michael Erickson
Glen Treser

VESSEL: Jack Seibel
Barry Sweet

CORPS OF ENGINEERS: Dick Ecker

Thursday 12 October, 1972 Area: Berkeley

0700 hrs.	Arrived vessel, turned instruments on, calibrated fathometer
0720 hrs.	Departed Berkeley Marina
0745 hrs.	Checked navigational system

Thursday 12 October, 1972 (Cont'd)

0820 hrs.	Gear in water, checked, Alden Recorder event mark inoperative, trigger intermittent on Uni-Boom, repaired Alden (broken wire) and Uni-Boom (adjusted trigger), lost navigation
0900 hrs.	Begin Line K
	End Line K
	Begin Line EE
1024 hrs.	End Line EE
	Begin Line E
1140 hrs.	End Line E
1213 hrs.	Begin Line KK
1245 hrs.	End Line KK
1256 hrs.	Begin Line D
1310 hrs.	Navigation down
1320 hrs.	Restart Line D
	End Line D
1440 hrs.	Begin Line FF
	End Line FF
1540 hrs.	Begin Line J (Rerun) Rerun due to navigational problems
	End Line J (Rerun)
	Begin Line DD
1630 hrs.	End Line DD
1655 hrs.	End Line DD
1700 hrs.	Departed survey area for Berkeley Marina

Aboard: James Miller
Bruce Manuel
Glen Treser
Mike Erickson
Jack Seibel
Barry Sweet
Dick Ecker

Friday 13 October, 1972 Area: Berkeley

0700 hrs.	Arrived vessel, turned instruments on, calibrated fathometer
0720 hrs.	Departed Berkeley Marina
0740 hrs.	Navigation check
0850 hrs.	Begin Line J
0911 hrs.	End Line J
0912 hrs.	Begin Line HH
0940 hrs.	Enc Line HH
1005 hrs.	Begin Line GG
1115 hrs.	End Line GG
1135 hrs.	Begin Line JJ
1140 hrs.	Generator down
1155 hrs.	Pick up Line JJ
1235 hrs.	End Line JJ
1245 hrs.	Begin Line F
1300 hrs.	Broke off Line F - Navigation
1325 hrs.	Restart Line F
	End Line F

Friday 13 October, 1972 (Cont'd)

1555 hrs.	Begin Line J
	End Line J
	Departed survey area for Berkeley Marina, off loaded equipment for weekend storage

Aboard: James Miller
Bruce Manuel
Mike Erickson
Dave Thomas
Jack Seibel
Barry Sweet
Dick Ecker

Monday 16 October, 1972 Area: Berkeley

0700 hrs.	Arrived dock
0730 hrs.	Vessel arrived
0800 hrs.	Began loading equipment
1000 hrs.	Equipment loaded, departed Berkeley Marina
1030 hrs.	Geophysical instruments checked
1100 hrs.	Navigation system check
1145 hrs.	Navigation checked, adjusted PESR, steaming for line
1158 hrs.	Begin Line BB
1250 hrs.	End Line BB
1259 hrs.	Begin Line G
1319 hrs.	End Line G
1326 hrs.	Begin Line CC
	End Line CC
	Begin Line L
	End Line L
	Adjusted Uni-Boom air-gap
1510 hrs.	Navigational check
	Begin Line XX
1600 hrs.	Broke off Line XX, Uni-Boom down, floating debris had broken connector on Transducer, departed survey area for Berkeley Marina

Aboard: James Miller
Bruce Manuel
Mike Erickson
Glen Tesser
Jack Seibel
Barry Sweet

1800 hrs.	Began repairs Uni-Boom
1930 hrs.	Repairs completed

Tuesday 17 October, 1972 Area: Berkeley

0710 hrs.	Arrived Berkeley Marina
0720 hrs.	Departed Berkeley Marina
0820 hrs.	Navigation checked and launched gear, PESR inoperative - repaired
0900 hrs.	Uni-Boom not keying, cable leaking, repaired

Tuesday 17 October, 1972 (Cont'd)

1014 hrs.	Begin Line K
1052 hrs.	End Line K
1110 hrs.	Begin Line XX
1200 hrs.	End Line XX
1203 hrs.	Begin Line G
1220 hrs.	End Line G
1225 hrs.	Begin Line H
	Broke off Line H (Navigation)
	Circling to pick up Line H
1350 hrs.	End Line H
1356 hrs.	Begin Line F
1425 hrs.	Broke off Line F, Hydrophone calbeintermittent
1485 hrs.	Restart Line F
1523 hrs.	End Line F
1555 hrs.	Begin Line J
1701 hrs.	End Line J
1702 hrs.	Begin Line AA
1720 hrs.	End Line AA
1725 hrs.	Depart survey area for Berkeley Marina

Aboard: James Miller
Bruce Manuel
Glen Treser
Mike Erickson
Jack Seibel
Barry Sweet

Wednesday 18 October, 1972 — Area: Berkeley

0720 hrs.	Arrive dock
0740 hrs.	Depart Berkely Marina
0825 hrs.	Navigation check
0941 hrs.	Begin Line GG
	End Line GG
1013 hrs.	Begin Line B
1045 hrs.	Broke off Line B (Navigation)
1052 hrs.	Restart Line B
1100 hrs.	End Line B
1105 hrs.	Begin Line JJ
1139 hrs.	End Line JJ
1142 hrs.	Corps of Engineers personnel aboard to observe and photograph operation.
1210 hrs.	Begin Line C
1259 hrs.	End Line C
1305 hrs.	Uni-Boom not triggering properly, replaced ceramic exciter shield and trigger electrodes
1406 hrs.	Begin Line FF
1458 hrs.	End Line FF
1459 hrs.	Begin Line A
1530 hrs.	Broke off Line A, Hydrophone signal intermittent, repaired.

Wednesday 18 October, 1972 (Cont'd)

1600 hrs.	Ready, Navigation down
1612 hrs.	Restart Line A
1700 hrs.	Broke off Line A turning mud (end of line)
1710 hrs.	Depart survey are for Berkeley Marina

Aboard: James Miller
Bruce Manuel
Glen Treser
Mike Erickson
Jack Seibel
Barry Sweet
Dick Ecker

Thursday 19 October, 1972 Area: Berkeley

0630 hrs.	Met John, gave him manuscript for new program
0710 hrs.	Arrive dock
0730 hrs.	Departed Berkeley Marina
0745 hrs.	Gear over & checked
0845 hrs.	Begin Line B-7
	End Line B-7
	Begin Line B-6
	End Line B-6
	Begin Line B-5
	End Line B-5
	Begin Line B-4
	End Line B-4
	Begin Line B-3
	End Line B-3
	Begin Line B-2
1003 hrs.	End Line B-2
1004 hrs.	Begin Line B-1
1130 hrs.	Broke off Line B-1
1135 hrs.	Restart Line B-1
1200 hrs.	End Line B-1
1220 hrs.	Begin Line B-8
1235 hrs.	End Line B-8
1237 hrs.	Begin Line B-9
1259 hrs.	End Line B-9
1300 hrs.	Begin Line B-10
1315 hrs.	Broke off Line B-10 (Navigation)
1340 hrs.	Restart Line B-10
1355 hrs.	End Line B-10
1356 hrs.	Begin Line B-11
1432 hrs.	End Line B-11
1433 hrs.	Begin Line B-12
1455 hrs.	End Line B-12
1456 hrs.	Begin Line B-13
1515 hrs.	End Line B-13

Thursday 19 October, 1972 (Cont'd)

1516 hrs.	Begin Line B-14
1535 hrs.	End Line B-14
1536 hrs.	Depart survey area for Berkeley Marina

Aboard: James Miller
Bruce Manuel
Dave Osborne
Mike Erickson
Jack Seibel
Barry Sweet

Friday 20 October, 1972 — Area: Oakland Harbor

0700 hrs.	Arrive dock
0730 hrs.	Departed Berkeley Marina
0745 hrs.	Launched and checked gear
0800 hrs.	Navigation check
0835 hrs.	Begin Line B
0914 hrs.	End Line B
0932 hrs.	Begin Line CC
0951 hrs.	End Line CC
	Lost navigation; John wants to move beginning of Line C approx. 1500' west and gradually bring the boat back to the pre-planned line as we go north
1017 hrs.	Begin Line C back on pre-planned line at fix 63
1038 hrs.	End Line C
1039 hrs.	Begin Line BB
1100 hrs.	End Line BB
1108 hrs.	Begin Line A
1143 hrs.	End Line A
	Begin Line AA
1208 hrs.	End Line AA
1213 hrs.	Begin Line B (Rerun)
1237 hrs.	End Line B (Rerun)
1242 hrs.	Begin Line D, 3.5 kc transceiver down after fix 182, continuing operation
1302 hrs.	End Line D
1309 hrs.	Change blade on Alden Recorder
1324 hrs.	Begin Line E
	End Line E
	Depart survey area for Berkeley Marina, unload and store equipment for weekend.

Aboard: James Miller
Bruce Manuel
Mike Erickson
Glen Treser
Jack Seibel
Barry Sweet
Dick Ecker

Monday 23 October, 1972 | Area: Carquinez Straits

0730 hrs. Arrived dock and began loading vessel
0910 hrs. Fueled vessel
1015 hrs. Depart Berkeley Marina for Carquinez Straits
1100 hrs. Checked gear
1330 hrs. Navigation check
1334 hrs. Begin Line Centerline ( )
1415 hrs. End Line
1421 hrs. Begin Line G
1452 hrs. End Line G
1453 hrs. Begin Line F
1510 hrs. End Line F
1514 hrs. Begin Line H
1545 hrs. End Line H
1546 hrs. Begin Line J
1558 hrs. Eng Line J
1621 hrs. Begin Line F
1627 hrs. End Line F. All possible from navigation set-up.

Aboard: James Miller
Bruce Manuel
Mike Erickson
Glen Treser
Jack Seibel
Barry Sweet

Tuesday 24 October, 1972 | Area: Carquinez

0720 hrs. Arrive Dowillio Marina
0730 hrs. Departed Dowillio Marina, heavy fog
1035 hrs. Fog clearing, checked equipmnnt
1042 hrs. Begin Line Centerline ( )
1146 hrs. End line Centerline ( )
1155 hrs. Begin Line F
1225 hrs. End Line F
1226 hrs. Begin Line E
1259 hrs. End Line E
1300 hrs. Begin Line EE
1322 hts. End Line EE
1324 hrs. Begin Line D
1405 Hrs. End Line D
1406 hrs. Begin Line DD
1426 hrs. End Line DD
1427 hrs. Begin Line C
Broke off Line C to avoid tanker in channel
Broke off Line C, navigation
1612 hrs. Restart Line C
1615 hrs. Broke off Line C, navigation
1645 hrs. Departed survey area

Aboard: James Miller
Bruce Manuel
Mike Erickson
Glen Treser
Jack Seibel
Barry Sweet

Wednesday 25 October, 1972 Area: Carquinez Straits

0730 hrs. Arrive dock
0740 hrs. Depart Dowillio Marine, gear checked
0830 hrs. Navigation check
0857 hrs. Begin Line Centerline ( )
0910 hrs. End Line Centerline ( )
1034 hrs. Begin Line HH
1051 hrs. End Line HH
3.5 kc records picking up interference from Uni-Boom; will continue running and try to isolate cause and repair
1113 hrs. Begin Line M
End Line M
Begin Line GG
1148 hrs. End Line GG
1149 hrs. Begin Line L
1156 hrs. End Line L
1157 hrs. Begin Line FF
1240 hrs. End Line FF
1241 hrs. Begin Line K
1243 hrs. End Line K
1244 hrs. Begin Line J
1300 hrs. End Line J
1302 hrs. Begin Line Centerline ( )
1400 hrs. End Line Centerline ( ), change navigation shore station
1530 hrs. Navigation shore station ready, Sparker electrode bad, changed
1557 hrs. Begin Line Centerline ( )
1619 hrs. End Line Centerline ( )
1630 hrs. Begin Line HH
1640 hrs. End Line HH
1641 hrs. Begin Line N
1658 hrs. End Line N
1659 hrs. Begin Line JJ
1720 hrs. End Line JJ
1721 hrs. Begin Line P
1727 hrs. End Line P
Depart survey area for Dowillio Marina
Working on 3.5 kc subbottom profiling system

Aboard: James Miller
Bruce Manuel
Glen Treser
Mike Erickson
Jack Seibel
Barry Sweet

Thursday 26 October, 1972 Area: Carquinez Straits

0730 hrs. Arrived Dowillio Marina
Began working on 3.5 kc subbottom profiler, replaced write board and motor amplifier board, not associated with problem, interference seems to be caused by the Uni-Boom inductively keying the 3.5 kc transceiver, grounding doesn't help, solution seems to be separation of units.

Thursday 26 October, 1972 (Cont'd)

0840 hrs.	Departed Dowillio Marina
1035 hrs.	Begin Line B
1057 hrs.	Broke off Line B, generator out of gas
1107 hrs.	Restart Line B
1201 hrs.	End Line B
	Cleaned & Adjusted air-gap on Sparker
1232 hrs.	Begin Line AA
1246 hrs.	End Line AA
1247 hrs.	Begin Line C
1315 hrs.	End Line C
1349 hrs.	Begin Line A
1514 hrs.	End Line A
1515 hrs.	Begin Line CC
1530 hrs.	End Line CC
1540 hrs.	Departed survey area
	Vessel moved from Dowillio Marina to Berkeley Marina

Aboard: James Miller
Bruce Manuel
Mike Erickson
Glen Treser
Jack Seibel
Barry Sweet

Friday 27 October, 1972 — Area: Oakland Harbor

0700 hrs.	Arrive Berkeley Marina
0720 hrs.	Depart Berkeley Marina
0850 hrs.	Begin Line A
0920 hrs.	End Line A
1011 hrs.	Begin Line Centerline (')
1106 hrs.	End Line Centerline ( )
1107 hrs.	Begin Line C
	Due to vessels at docks, shore station would be unable to track survey vessel if pre-planned line were followed. After consulting with Mr. Dick Ecker, Corps of Engineers representative, it was decided to change lines so that diagonals run from NE to SW instead of NW to SE.
1205 hrs.	End Line C
	Begin Line Centerline (C)
	End Line Centerline ( )
	Begin Line ZZ
	End Line ZZ
	Begin Line Centerline ( )
	End Line Centerline ( )
1529 hrs.	Begin Line X
	End Line X
	Departed survey area for Berkeley Marina, unloaded and store equipment.

Aboard: James Miller, Bruce Manuel, Mike Erickson, Nestor Acosta, Jack Seibel, Barry Sweet, Dick Ecker

Monday 30 October, 1972 — Area: Carquinez Straits

0730 hrs.	Arrived Berkeley Marina, began loading vessel
0900 hrs.	Depart Berkeley Marina
1256 hrs.	Begin Line J
1306 hrs.	End Line J
1307 hrs.	Begin Line K
1313 hrs.	End Line K
1314 hrs.	Begin Line FF
	End Line FF
	Begin Line L
	End Line L
1355 hrs.	Begin Line GG
1437 hrs.	End Line GG
1438 hrs.	Begin Line M
1445 hrs.	End Line M
1446 hrs.	Begin Line HH
1530 hrs.	End Line HH
1535 hrs.	Begin Line Centerline (℄)
	End Line Centerline (℄)
	Depart survey area

Aboard: James Miller
Bruce Manuel
Mike Erickson
Dave Osborne
Jack Seibel
Barry Sweet

Tuesday 31 October, 1972 — Area: Carquinez Straits

0705 hrs.	Arrived Dowillio Marina
0740 hrs.	Departed Dowillio Marina
0828 hrs.	Begin Line N
0854 hrs.	End Line N
0855 hrs.	Begin Line JJ
0913 hrs.	End Line JJ
0914 hrs.	Begin Line P
0930 hrs.	End Line P
0931 hrs.	Begin Line RR
0944 hrs.	End Line RR
0945 hrs.	Begin Line R
0959 hrs.	End Line R
1000 hrs.	Begin Line S
1011 hrs.	End Line S
1014 hrs.	Begin Line Centerline (℄)
1055 hrs.	End Line Centerline (℄)
1142 hrs.	Begin Line T
	End Line T
	Departed survey area for Berkeley Marina
1601 hrs.	Unloaded equipment into truck

Aboard: James Miller, Bruce Manuel, Mike Erickson, Dave Osborne, Jack Seibel, Barry Sweet

Wednesday 1 November, 1972

Demobilizing equipment
0900 hrs. Briefing at Corps of Engineers

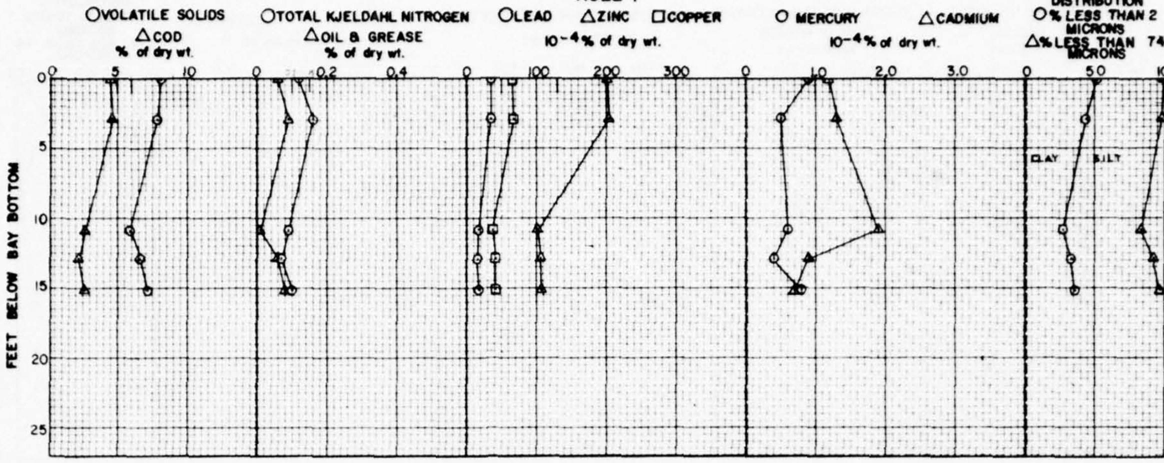
Thursday 2 November, 1972

Demobilizing
Departed for Norwood

INCLOSURE 4

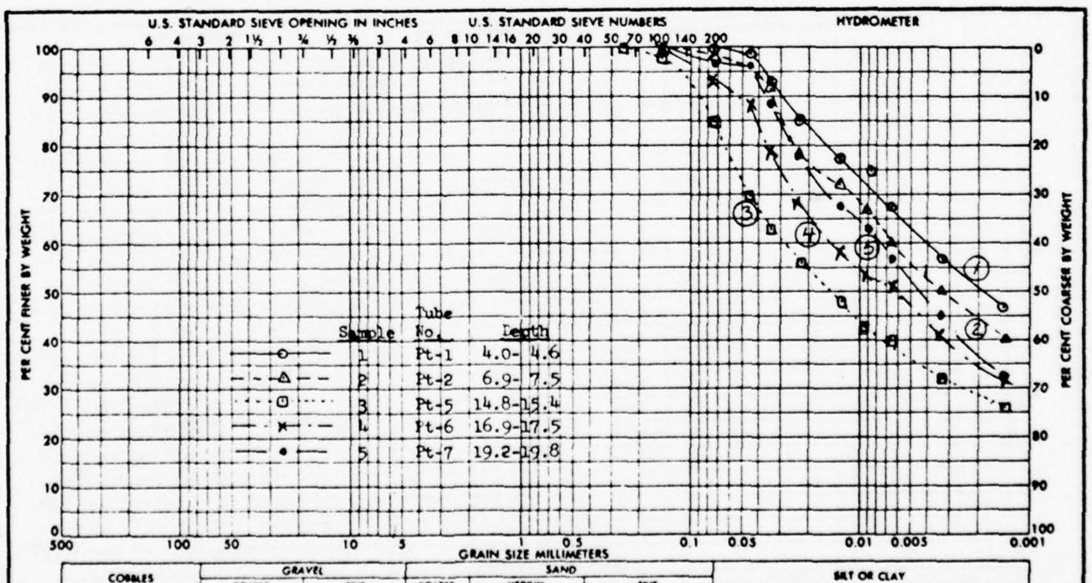
CORE SAMPLES: POLLUTANT DISTRIBUTION STUDY

HOLE 1



Hole No. 2D-148 (1)

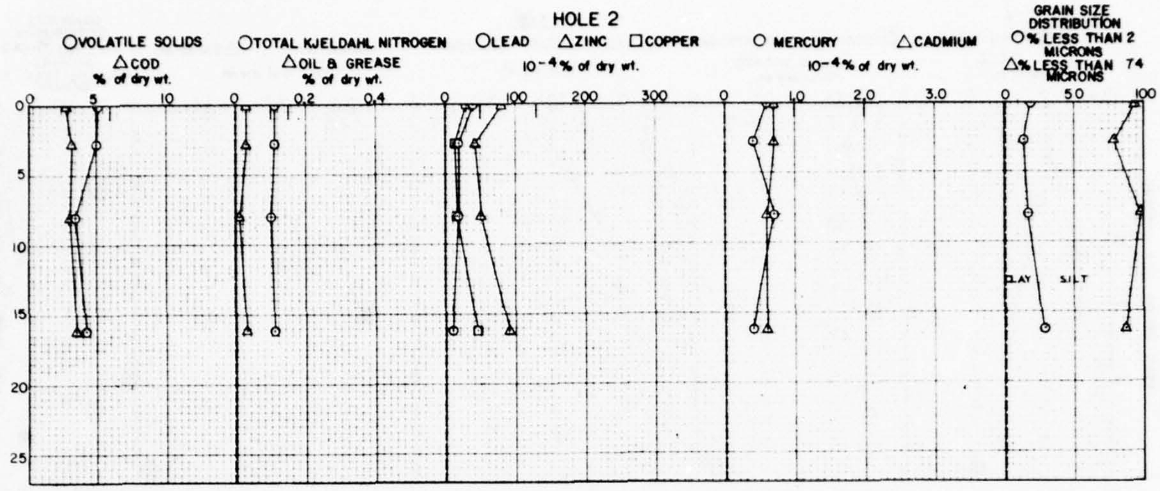
Field Sample No.	PT-1	PT-2	PT-5	PT-6	PT-7
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-1095	PC-1096	PC-1097	PC-1098	PC-1099
Volatile Solids, % of dry wt.	8.2	7.8	5.8	6.6	7.2
C.O.D., % of dry wt.	4.5	4.6	2.7	2.3	2.6
Total Kjeldahl Nitrogen, % of dry wt.	0.12	0.16	0.09	0.07	0.10
Oil and Grease, % of dry wt.	0.06	0.09	0.01	0.06	0.08
Mercury (Hg), 10^{-4} % of dry wt.	0.9	0.5	0.6	0.4	0.8
Lead (Pb), 10^{-4} % of dry wt.	36	35	19	18	19
Zinc (Zn), 10^{-4} % of dry wt.	201	204	103	106	107
Cadmium (Cd), 10^{-4} % of dry wt.	1.2	1.3	1.9	0.9	0.7
Copper (Cu), 10^{-4} % of dry wt.	66	68	38	41	41



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
Pt-1	4.0- 6.5		128.6			
Pt-2	6.5- 9.0		117.6			
Pt-5	14.0-16.5		74.1			
Pt-6	16.5-19.0		82.3			
Pt-7	19.0-21.5		86.2			

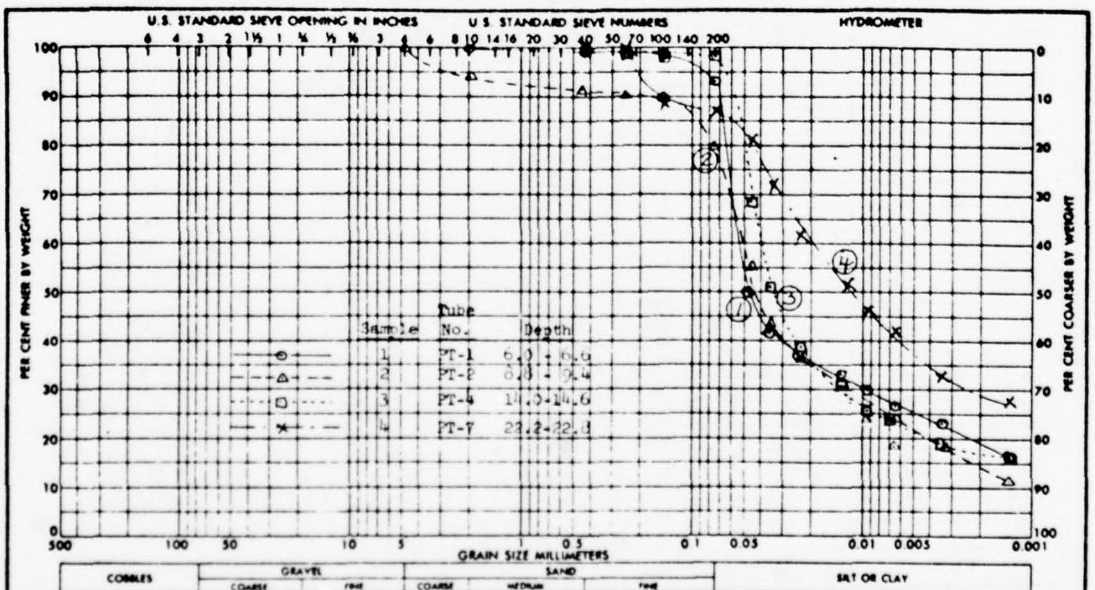
GRADATION CURVES

PROJECT SAN FRANCISCO BAY & ESTUARY
Dredge Material Disposal Study
AREA Carquines Strait to Oakland Estuary
BORING NO. 2D-148 (1)
DATE Jan 1974



Hole No. 2D-135 (2)

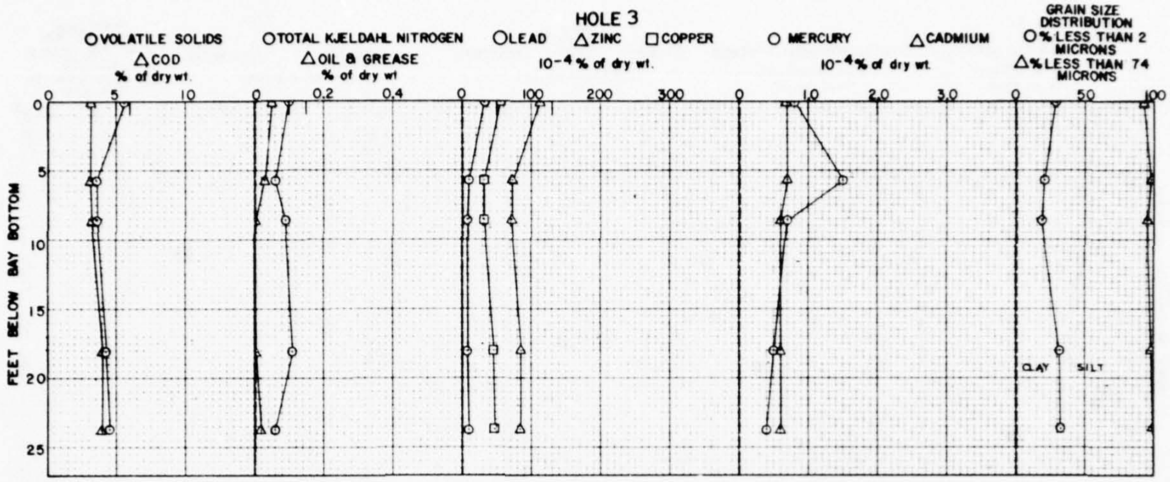
Field Sample No.	**PT-1**	PT-2	PT-4	PT-7
Laboratory Sample No.	1	2	3	4
Laboratory No.	PC-1034	PC-1035	PC-1036	PC-1037
Volatile Solids, % of dry wt.	5.1	5.0	3.5	4.3
C.O.D., % of dry wt.	2.8	3.3	3.2	3.6
Total Kjeldahl Nitrogen, % of dry wt.	0.11	0.11	0.10	0.11
Oil and Grease, % of dry wt.	0.03	0.03	0.01	0.03
Mercury (Hg), 10^{-4} % of dry wt.	0.6	0.4	0.7	0.4
Lead (Pb), 10^{-4} % of dry wt.	40	19	19	10
Zinc (Zn), 10^{-4} % of dry wt.	80	42	51	91
Cadmium (Cd), 10^{-4} % of dry wt.	0.7	0.7	0.6	0.6
Copper (Cu), 10^{-4} % of dry wt.	30	14	17	46



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	6.0 - 8.5					
PT-2	8.5 -11.0					
PT-4	13.5-16.0		46.1			
PT-7	21.0-23.5		53.4			

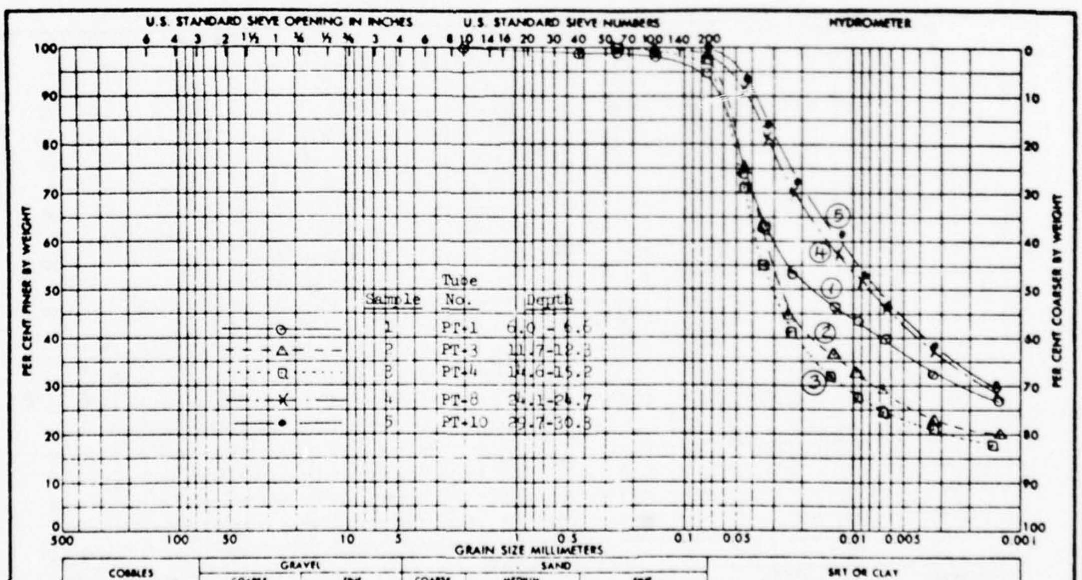
GRADATION CURVES

PROJECT SAN FRANCISCO BAY & ESTUARY
Dredge Material Disposal Study
AREA Carquinez Strait to Oakland Estuary
BORING NO 2D-135 (2)
DATE December 1973



Hole No. 2D-136 (3)

Field Sample No.	PT-1	PT-3	PT-4	PT-8	PT-10
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-1038	PC-1039	PC-1040	PC-1041	PC-1042
Volatile Solids, % of dry wt.	5.6	3.6	3.6	4.3	4.5
C.O.D., % of dry wt.	3.2	3.2	3.3	4.0	4.0
Total Kjeldahl Nitrogen, % of dry wt.	0.10	0.06	0.09	0.11	0.06
Oil and Grease, % of dry wt.	0.05	0.03	0.01-	0.01-	0.02
Mercury (Hg), 10^{-4} % of dry wt.	0.8	1.5	0.7	0.5	0.4
Lead (Pb), 10^{-4} % of dry wt.	31	10	8	8	10
Zinc (Zn), 10^{-4} % of dry wt.	113	73	72	85	84
Cadmium (Cd), 10^{-4} % of dry wt.	0.7	0.7	0.6	0.6	0.6
Copper (Cu), 10^{-4} % of dry wt.	55	32	31	46	47



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	6.0 - 8.5		67.7			
PT-3	11.0-13.5		48.9			
PT-4	13.5-16.0		45.3			
PT-8	23.5-[illegible].0		56.1			
PT-10	28.5-31.0		60.7			

GRADATION CURVES

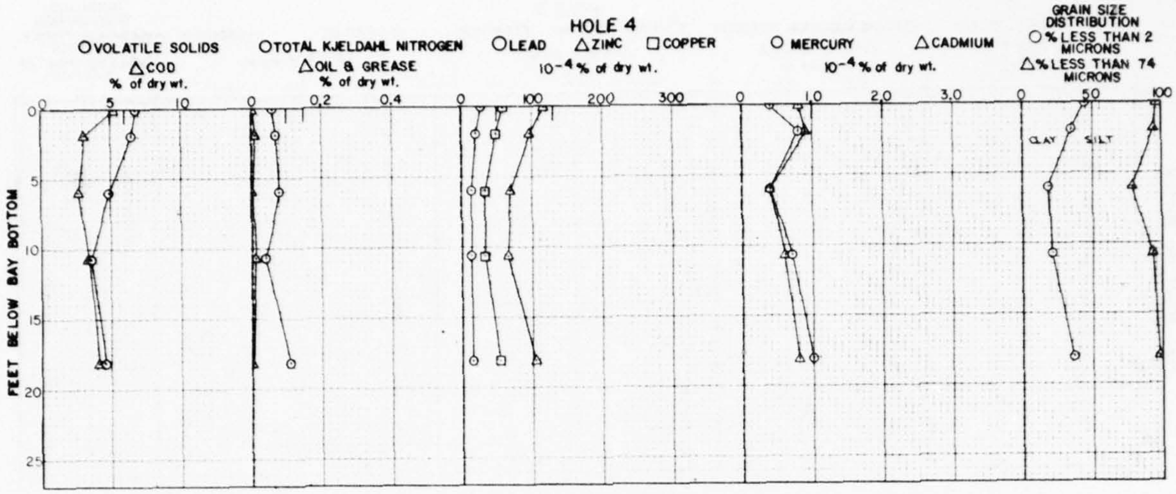
PROJECT SAN FRANCISCO BAY & ESTUARY

Dredge Material Disposal Study

AREA Carquinez Strait to Oakland Estuary

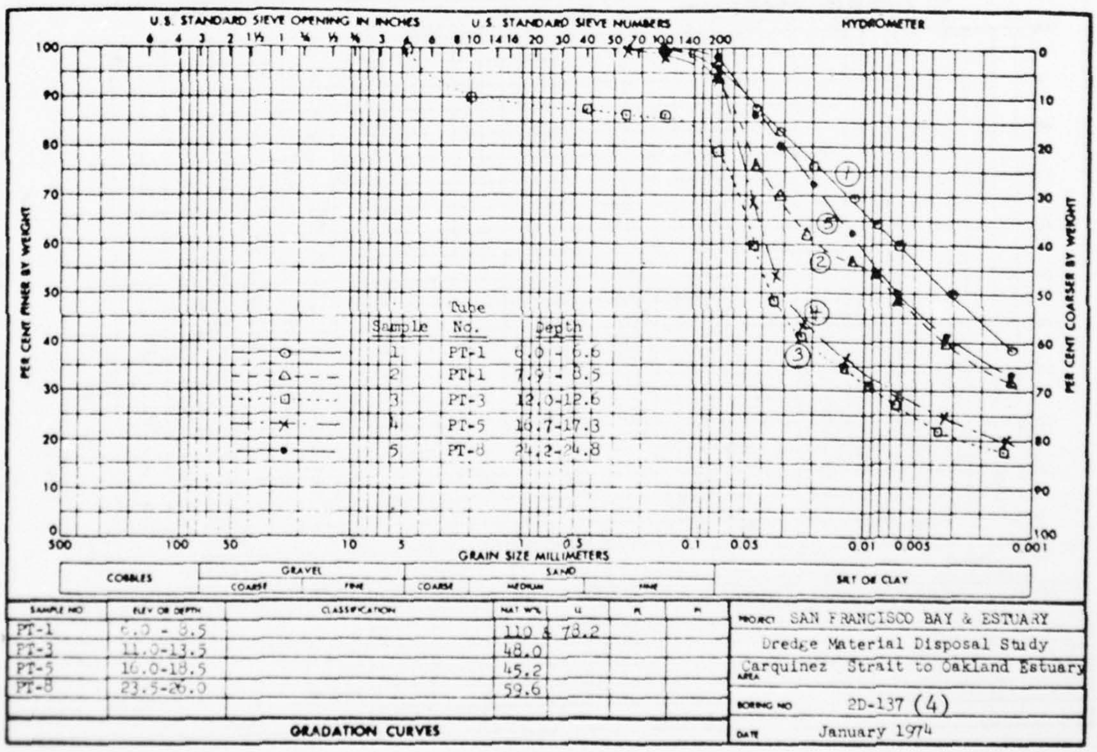
BORING NO 2D-136 (3)

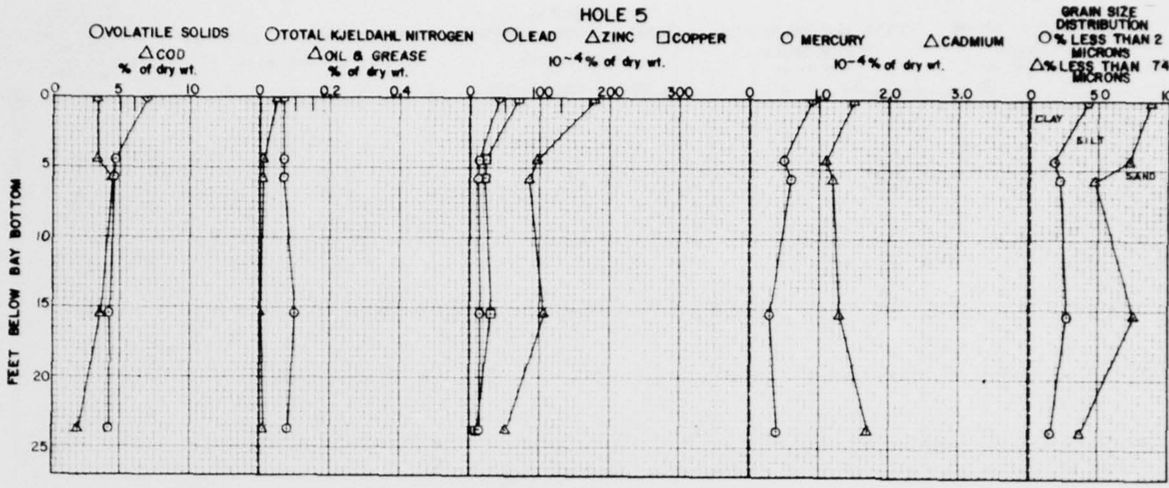
DATE January 1974



Hole No. 2D-137 (4)

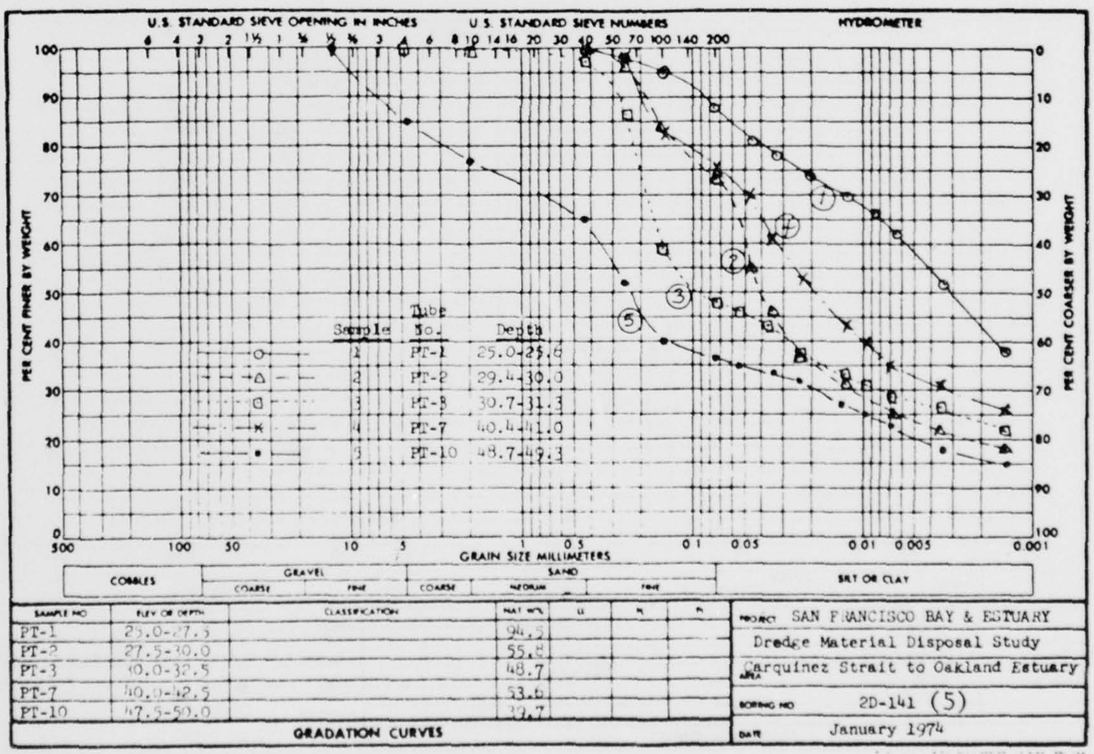
Field Sample No.	PT-1	PT-1	PT-3	PT-5	PT-8
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-1043	PC-1044	PC-1045	PC-1046	PC-1047
Volatile Solids, % of dry wt.	6.7	6.5	4.9	3.6	4.6
C.O.D., % of dry wt.	5.2	3.2	2.7	3.4	4.2
Total Kjeldahl Nitrogen, % of dry wt.	0.06	0.07	0.08	0.04	0.11
Oil and Grease, % of dry wt.	0.01-	0.01	0.01-	0.01	0.01-
Mercury (Hg), 10^{-4} % of dry wt.	0.4	0.8	0.4	0.7	1.0
Lead (Pb), 10^{-4} % of dry wt.	28	20	13	13	16
Zinc (Zn), 10^{-4} % of dry wt.	116	98	69	66	104
Cadmium (Cd), 10^{-4} % of dry wt.	0.8	0.9	0.4	0.6	0.8
Copper (Cu), 10^{-4} % of dry wt.	59	49	33	32	53

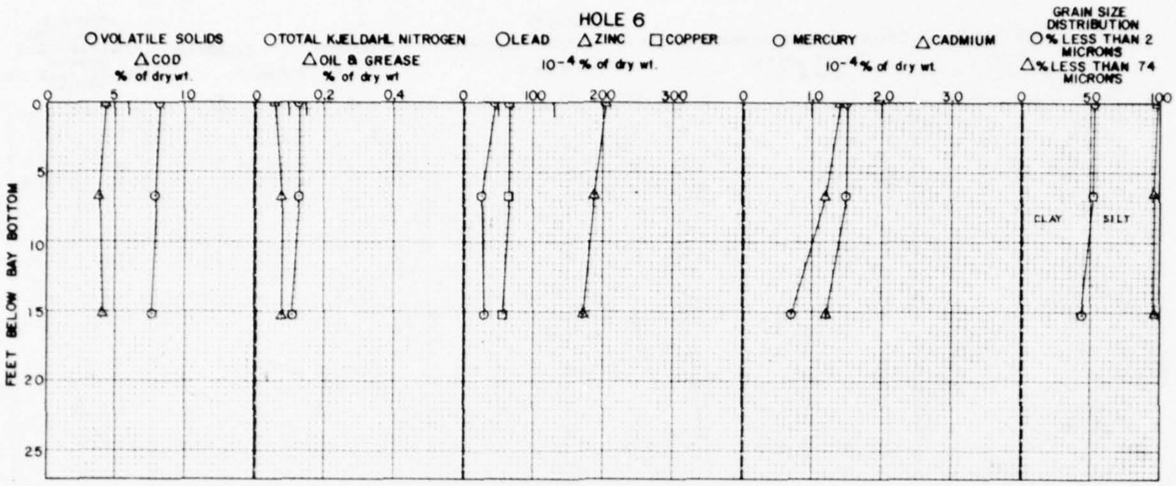




Hole No. 2D-141 (5)

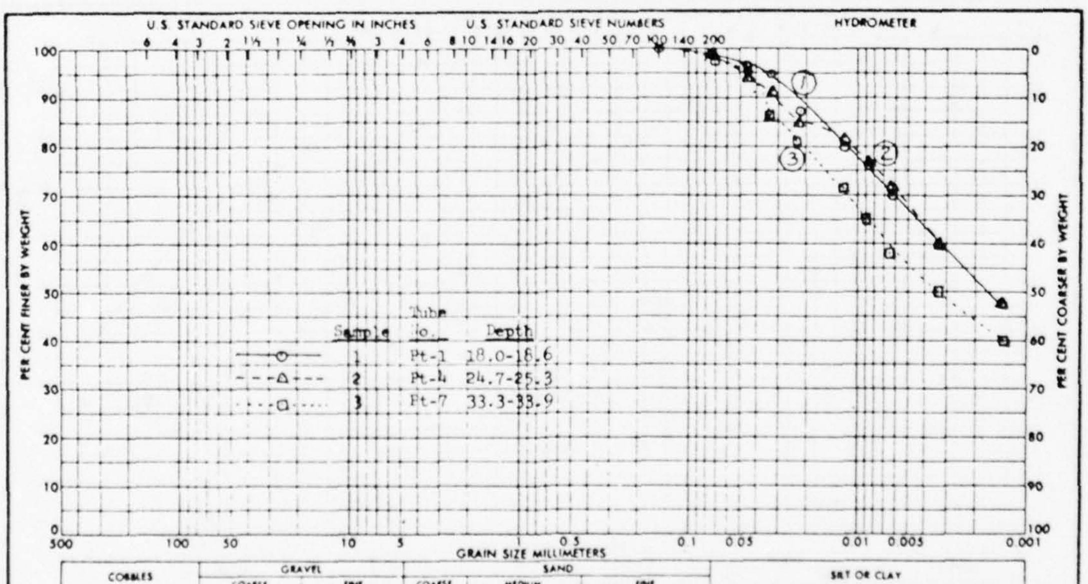
Field Sample No.	PT-1	PT-2	PT-3	PT-7	PT-10
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-1061	PC-1062	PC-1063	PC-1064	PC-1065
Volatile Solids, % of dry wt.	6.9	4.7	4.6	4.3	4.3
C.O.D., % of dry wt.	3.4	3.4	4.5	3.6	2.0
Total Kjeldahl Nitrogen, % of dry wt.	0.07	0.07	0.07	0.10	0.08
Oil and Grease, % of dry wt.	0.05	0.01	0.01	0.01-	0.01
Mercury (Hg), 10^{-4} % of dry wt.	0.9	0.5	0.6	0.3	0.4
Lead (Pb), 10^{-4} % of dry wt.	42	14	13	15	15
Zinc (Zn), 10^{-4} % of dry wt.	179	97	87	107	52
Cadmium (Cd), 10^{-4} % of dry wt.	1.5	1.1	1.2	1.3	1.7
Copper (Cu), 10^{-4} % of dry wt.	70	23	23	31	12





Hole No. 2D-147 (6)

Field Sample No.	PT-1	PT-4	PT-7
Laboratory Sample No.	1	2	3
Laboratory No.	PC-1092	PC-1093	PC-1094
Volatile Solids, % of dry wt.	8.3	7.9	7.7
C.O.D., % of dry wt.	4.4	3.9	4.2
Total Kjeldahl Nitrogen, % of dry wt.	0.13	0.13	0.11
Oil and Grease, % of dry wt.	0.06	0.08	0.08
Mercury (Hg), 10^{-4} % of dry wt.	1.5	1.5	0.7
Lead (Pb), 10^{-4} % of dry wt.	46	28	30
Zinc (Zn), 10^{-4} % of dry wt.	205	189	172
Cadmium (Cd), 10^{-4} % of dry wt.	1.4	1.2	1.2
Copper (Cu), 10^{-4} % of dry wt.	67	66	57



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
Pt-1	18.0-20.5		137.3			
Pt-4	25.5-28.0		105.6			
Pt-7	33.0-35.5		105.9			

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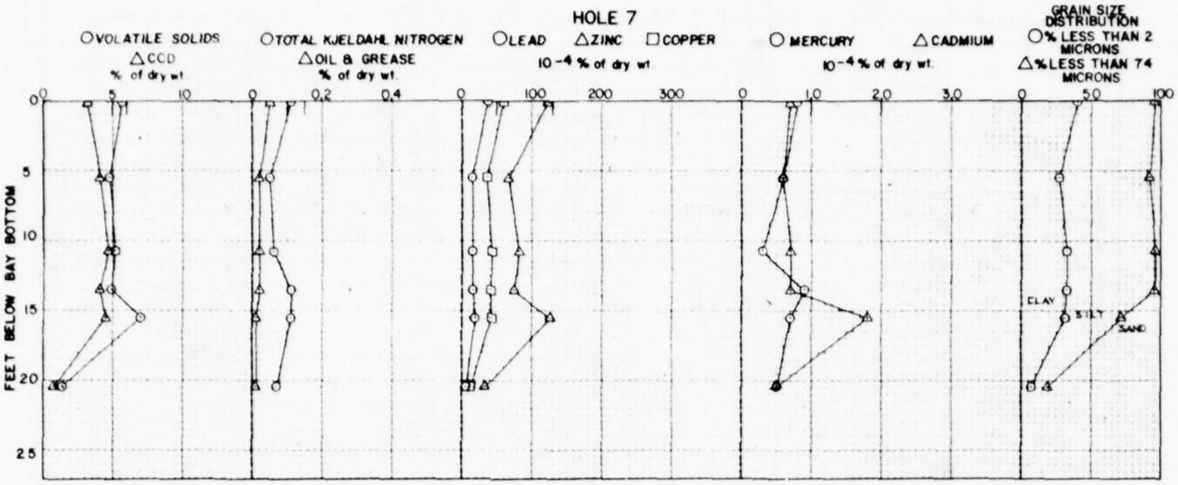
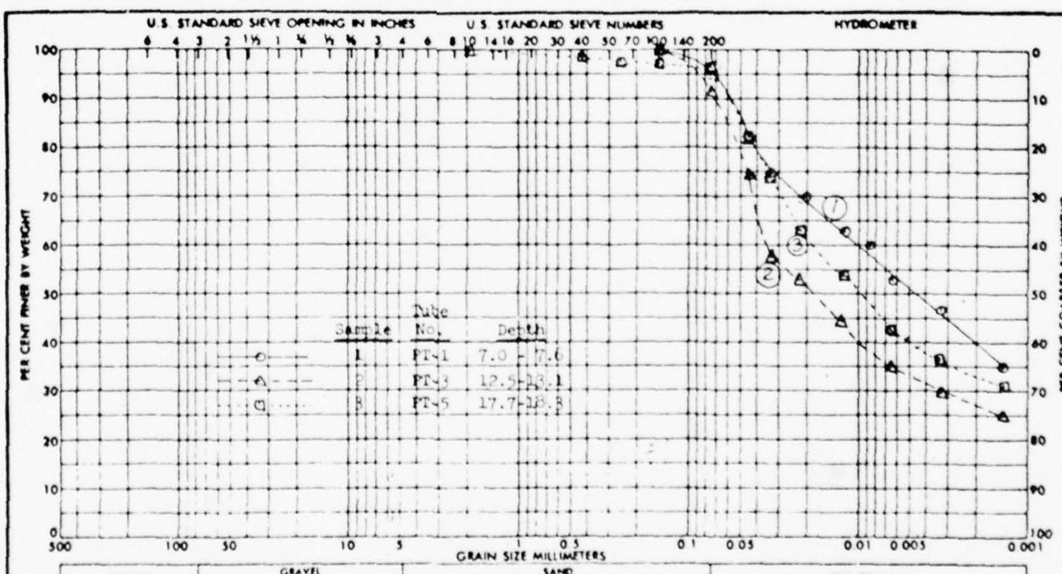


Hole No. 2D-138 (7)

Field Sample No.	PT-1	PT-3	PT-5	PT-6	PT-7	PT-9
Laboratory Sample No.	1	2	3	4	5	6
Laboratory No.	PC-1048	PC-1049	PC-1050	PC-1051	PC-1052	PC-1053
Volatile Solids, % of dry wt.	5.7	4.8	5.2	4.9	7.0	1.4
C.O.D., % of dry wt.	3.2	4.1	4.7	4.1	4.5	0.8
Total Kjeldahl Nitrogen, % of dry wt.	0.11	0.05	0.06	0.11	0.11	0.07
Oil and Grease, % of dry wt.	0.05	0.02	0.02	0.02	0.01	0.01
Mercury (Hg), 10^{-4} % of dry wt.	0.8	0.6	0.3	0.9	0.7	0.5
Lead (Pb), 10^{-4} % of dry wt.	38	15	15	16	19	5
Zinc (Zn), 10^{-4} % of dry wt.	123	68	82	75	127	33
Cadmium (Cd), 10^{-4} % of dry wt.	0.7	0.6	0.7	0.7	1.8	0.5
Copper (Cu), 10^{-4} % of dry wt.	60	36	43	41	42	13



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	7.0 - 9.5		87.2			
PT-3	12.0-14.5		63.7			
PT-5	17.0-19.5		66.4			

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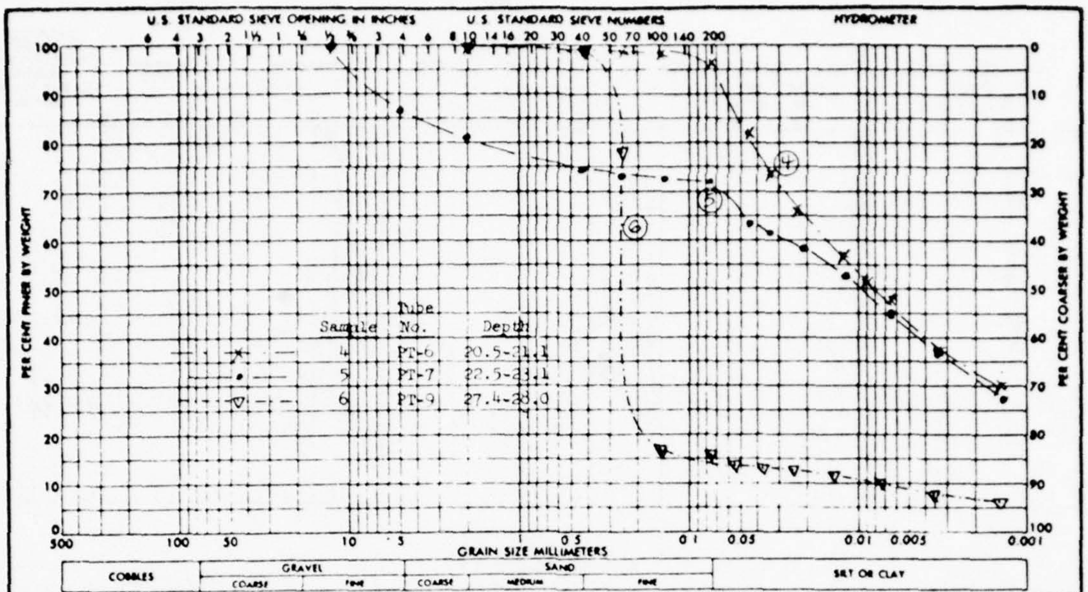

SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-6	19.5-22.0		67.8			
PT-7	22.0-24.5		75.2			
PT-9	27.0-29.5		22.5			

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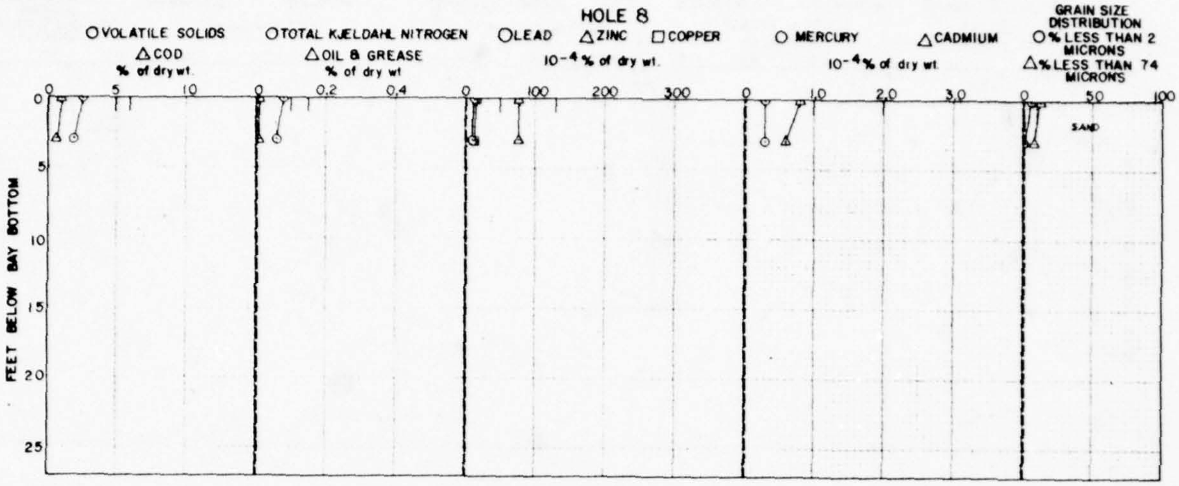
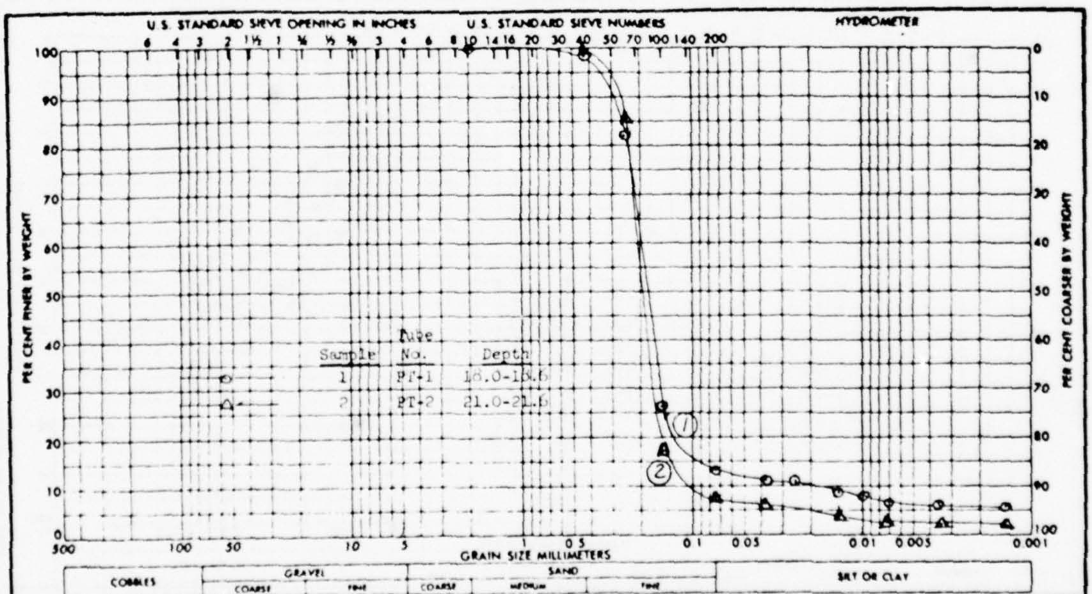


Hole No. 2D-139 (8)

	PT-1	PT-2
Field Sample No.	PT-1	PT-2
Laboratory Sample No.	1	2
Laboratory No.	PC-1054	PC-1055
Volatile Solids, % of dry wt.	2.6	2.0
C.O.D., % of dry wt.	1.1	0.7
Total Kjeldahl Nitrogen, % of dry wt.	0.08	0.06
Oil and Grease, % of dry wt.	0.01	0.01
Mercury (Hg), 10^{-4} % of dry wt.	0.3	0.3
Lead (Pb), 10^{-4} % of dry wt.	13	11
Zinc (Zn), 10^{-4} % of dry wt.	77	77
Cadmium (Cd), 10^{-4} % of dry wt.	0.8	0.6
Copper (Cu), 10^{-4} % of dry wt.	16	13



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	18.0-20.5		32.5			
PT-2	20.5-23.0		26.1			

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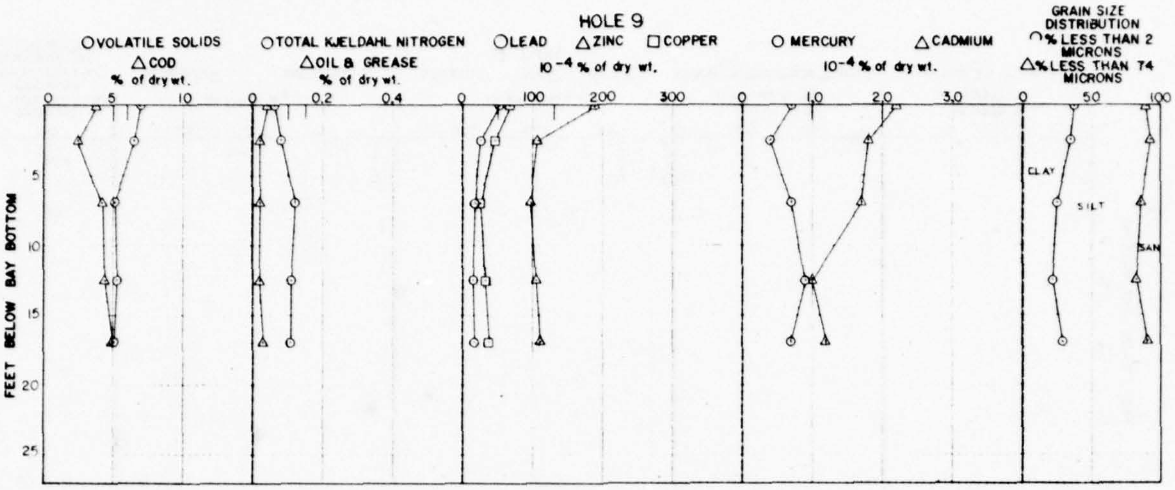
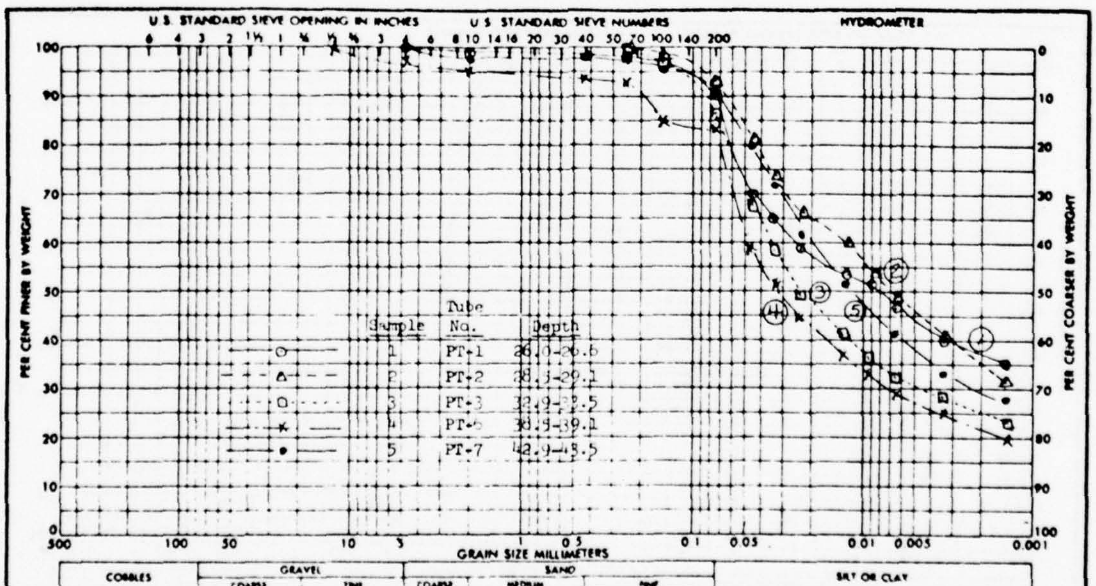


Hole No. 2D-140 (9)

Field Sample No.	PT-1	PT-2	PT-3	PT-6	PT-7
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-1056	PC-1057	PC-1058	PC-1059	PC-1060
Volatile Solids, % of dry wt.	6.9	6.5	5.1	5.3	5.1
C.O.D., % of dry wt.	3.7	2.5	4.3	4.4	5.0
Total Kjeldahl Nitrogen, % of dry wt.	0.06	0.08	0.12	0.11	0.11
Oil and Grease, % of dry wt.	0.04	0.02	0.02	0.02	0.03
Mercury (Hg), 10^{-4} % of dry wt.	0.7	0.4	0.7	0.9	0.7
Lead (Pb), 10^{-4} % of dry wt.	51	26	18	14	17
Zinc (Zn), 10^{-4} % of dry wt.	188	108	98	105	111
Cadmium (Cd), 10^{-4} % of dry wt.	2.2	1.8	1.7	1.0	1.2
Copper (Cu), 10^{-4} % of dry wt.	67	47	25	33	39



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	26.0-28.5		90.1			
PT-2	28.3-31.0		70.0			
PT-3	31.0-33.5		67.6			
PT-6	38.5-41.0		60.1			
PT-7	41.0-43.5		72.1			

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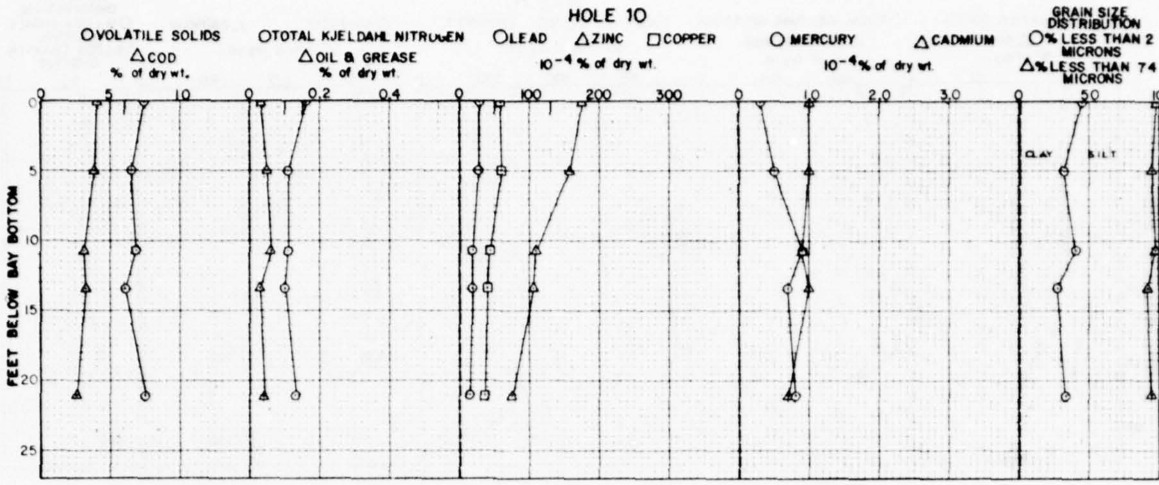
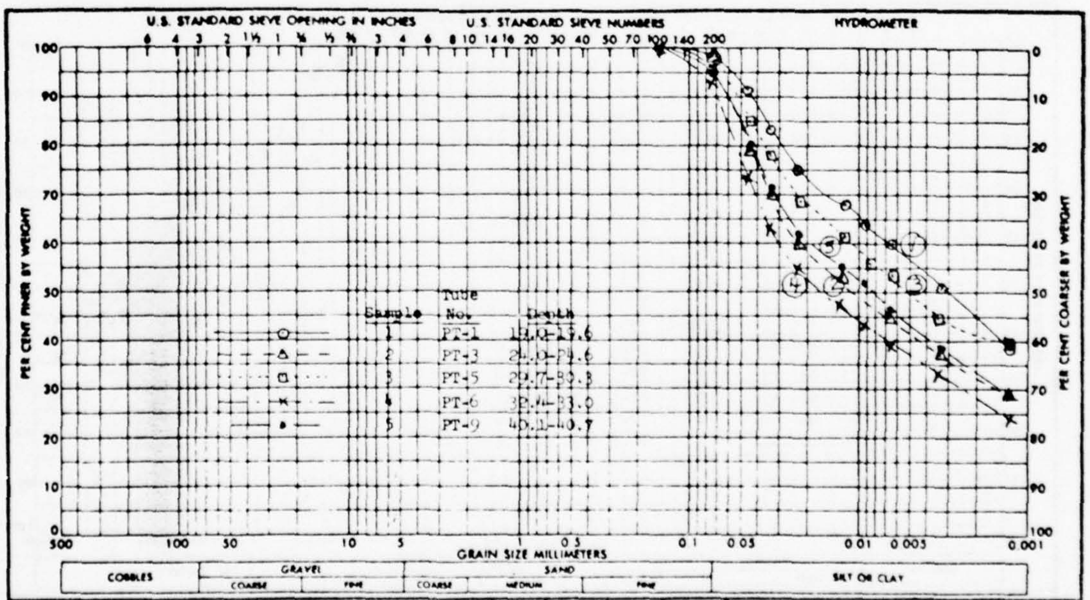


Hole No. 2D-143 (10)

Field Sample No.	PT-1	PT-3	PT-5	PT-6	PT-9
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-1070	PC-1071	PC-1072	PC-1073	PC-1074
Volatile Solids, % of dry wt.	7.4	6.5	6.8	6.1	7.5
C.O.D., % of dry wt.	4.1	3.8	3.2	3.3	2.6
Total Kjeldahl Nitrogen, % of dry wt.	0.16	0.11	0.11	0.10	0.13
Oil and Grease, % of dry wt.	0.03	0.05	0.06	0.03	0.04
Mercury (Hg), 10^{-4} % of dry wt.	0.3	0.5	0.9	0.7	0.8
Lead (Pb), 10^{-4} % of dry wt.	29	28	19	19	14
Zinc (Zn), 10^{-4} % of dry wt.	175	157	109	106	75
Cadmium (Cd), 10^{-4} % of dry wt.	1.0	1.0	0.9	1.0	0.7
Copper (Cu), 10^{-4} % of dry wt.	59	60	44	40	35



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	19.0-21.5		116.8			
PT-3	24.0-26.5		92.0			
PT-5	29.0-31.5		93.0			
PT-6	31.5-34.0		88.9			
PT-9	39.0-41.5		76.0			

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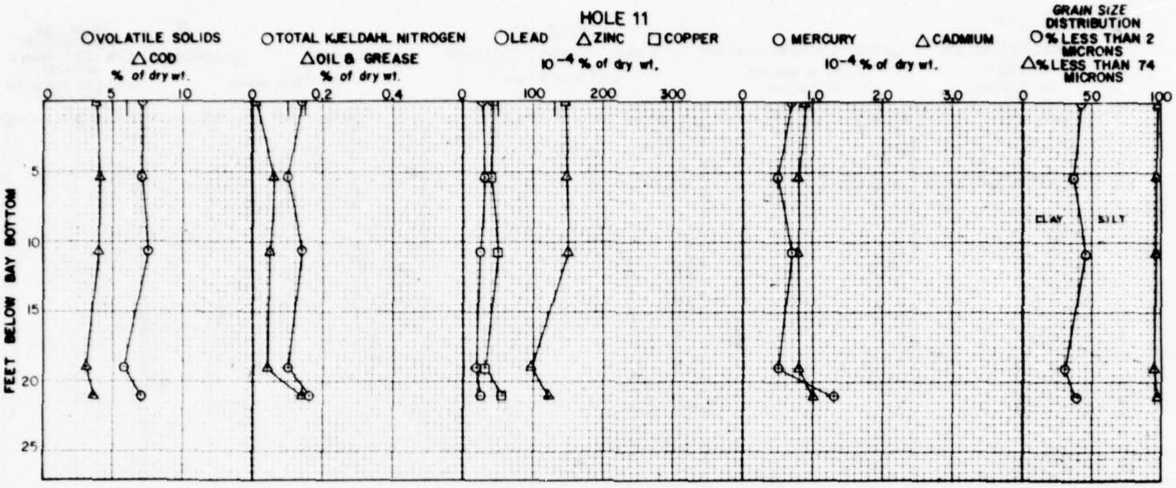
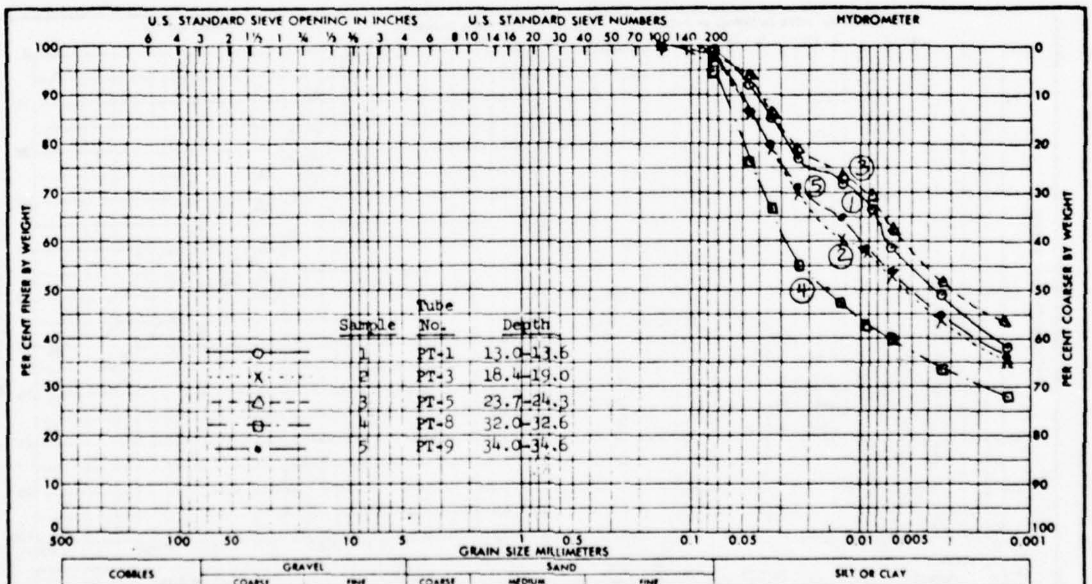


Hole No. 2D-144 (11)

Field Sample No.	PT-1	PT-3	PT-5	PT-8	PT-9
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-1076	PC-1077	PC-1078	PC-1079	PC-1080
Volatile Solids, % of dry wt.	7.6	7.1	7.5	5.7	7.0
C.O.D., % of dry wt.	3.9	4.2	4.0	3.1	3.6
Total Kjeldahl Nitrogen, % of dry wt.	0.14	0.10	0.14	0.10	0.16
Oil and Grease, % of dry wt.	0.01-	0.06	0.05	0.04	0.14
Mercury (Hg), 10^{-4} % of dry wt.	0.7	0.5	0.7	0.5	1.3
Lead (Pb), 10^{-4} % of dry wt.	29	31	25	19	25
Zinc (Zn), 10^{-4} % of dry wt.	145	148	150	98	121
Cadmium (Cd), 10^{-4} % of dry wt.	0.9	0.8	0.8	0.8	1.0
Copper (Cu), 10^{-4} % of dry wt.	42	41	50	31	53



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	13.0-15.5		129.4			
PT-3	18.0-20.5		101.9			
PT-5	23.0-25.5		105.5			
PT-8	30.5-33.0		66.9			
PT-9	33.0-35.5		86.2			

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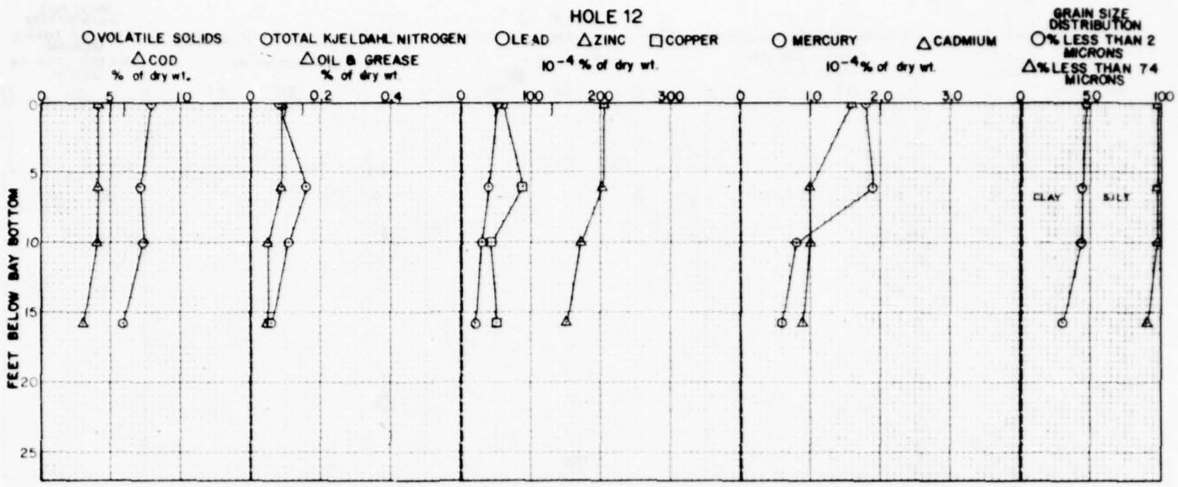
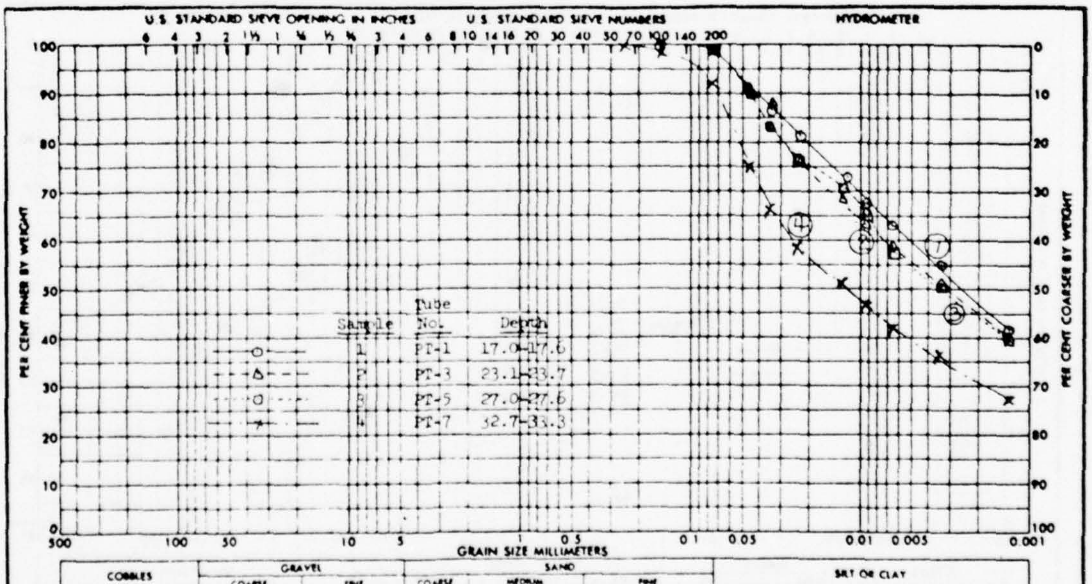


Hole No. 2D-142 (12)

Field Sample No.	PT-1	PT-3	PT-5	PT-7
Laboratory Sample No.	1	2	3	4
Laboratory No.	PC-1066	PC-1067	PC-1068	PC-1069
Volatile Solids, % of dry wt.	7.9	7.2	7.4	5.9
C.O.D., % of dry wt.	4.2	4.2	4.1	3.1
Total Kjeldahl Nitrogen, % of dry wt.	0.08	0.16	0.11	0.06
Oil and Grease, % of dry wt.	0.09	0.09	0.05	0.05
Mercury (Hg), 10^{-4} % of dry wt.	1.8	1.9	0.8	0.6
Lead (Pb), 10^{-4} % of dry wt.	54	40	30	22
Zinc (Zn), 10^{-4} % of dry wt.	205	203	173	152
Cadmium (Cd), 10^{-4} % of dry wt.	1.6	1.0	1.0	0.9
Copper (Cu), 10^{-4} % of dry wt.	61	89	44	52



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	17.0-19.5		121.2			
PT-3	22.0-24.5		110.3			
PT-5	27.0-29.5		99.9			
PT-7	32.0-34.5		76.1			

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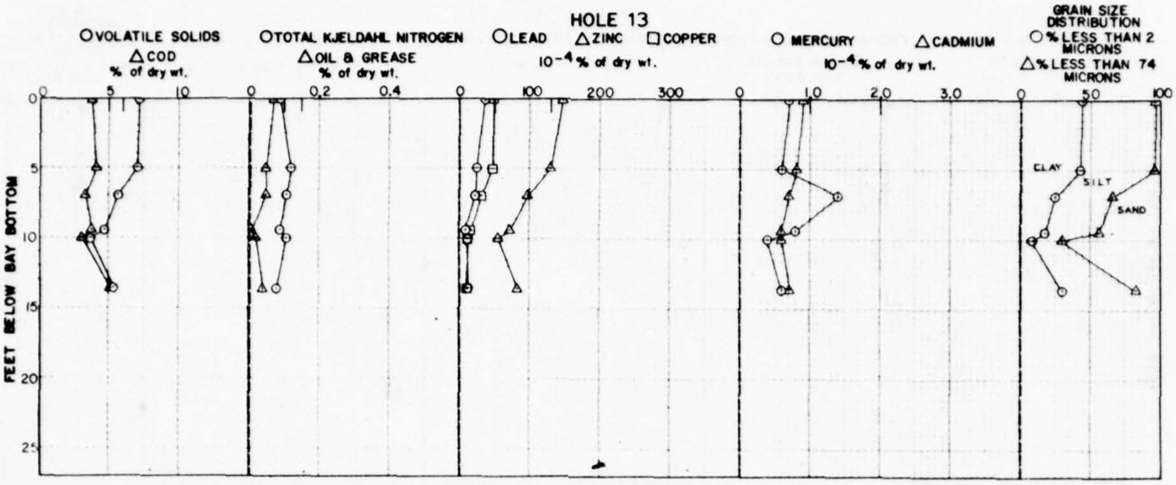
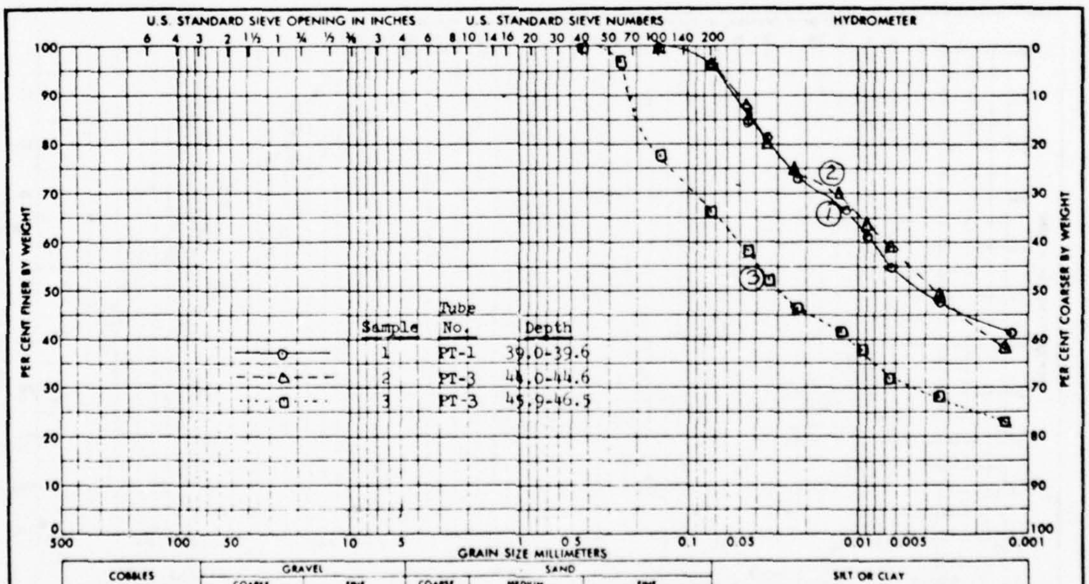


Hole No. 2D-145 (13)

Field Sample No.	PT-1	PT-3	PT-3	PT-4	PT-5	PT-6
Laboratory Sample No.	1	2	3	4	5	6
Laboratory No.	PC-1081	PC-1082	PC-1083	PC-1084	PC-1085	PC-1086
Volatile Solids, % of dry wt.	7.2	7.1	5.7	4.7	3.7	5.4
C.O.D., % of dry wt.	3.8	4.2	3.4	3.8	3.2	5.2
Total Kjeldahl Nitrogen, % of dry wt.	0.09	0.12	0.11	0.09	0.11	0.08
Oil and Grease, % of dry wt.	0.07	0.05	0.05	0.01-	0.02	0.04
Mercury (Hg), 10^{-4} % of dry wt.	0.7	0.6	1.4	0.8	0.4	0.6
Lead (Pb), 10^{-4} % of dry wt.	37	25	24	10	11	14
Zinc (Zn), 10^{-4} % of dry wt.	148	130	99	74	57	83
Cadmium (Cd), 10^{-4} % of dry wt.	0.9	0.8	0.7	0.6	0.6	0.7
Copper (Cu), 10^{-4} % of dry wt.	49	47	32	18	12	13



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	39.0-41.5		116.9			
PT-3	44.0-46.5		103.3 & 71.6			

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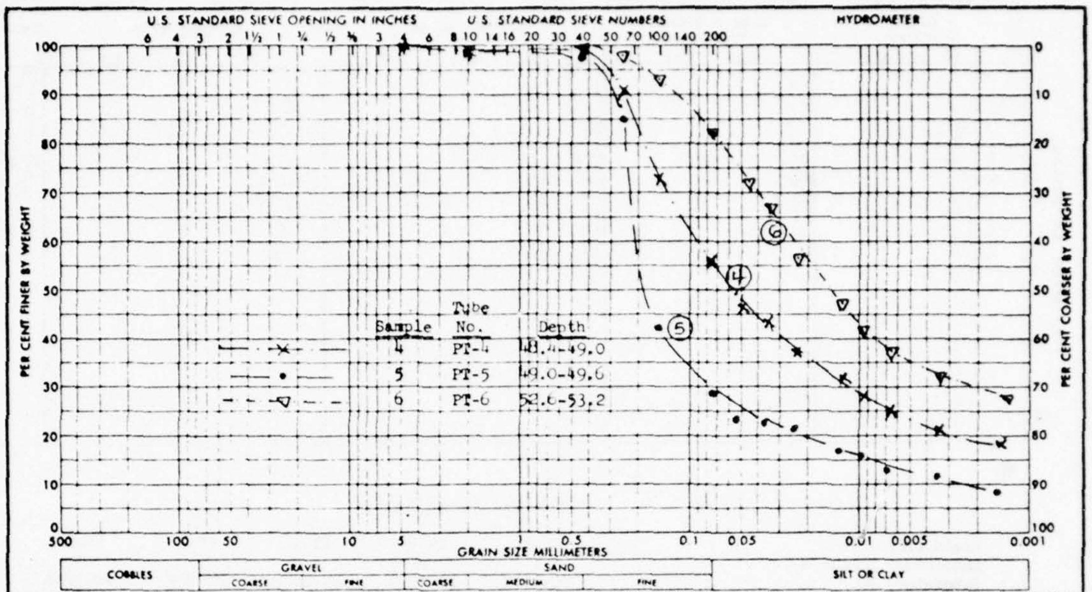

SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-4	46.5-49.0		55.7			
PT-5	49.0-51.5		41.5			
PT-6	51.5-54.0		77.0			

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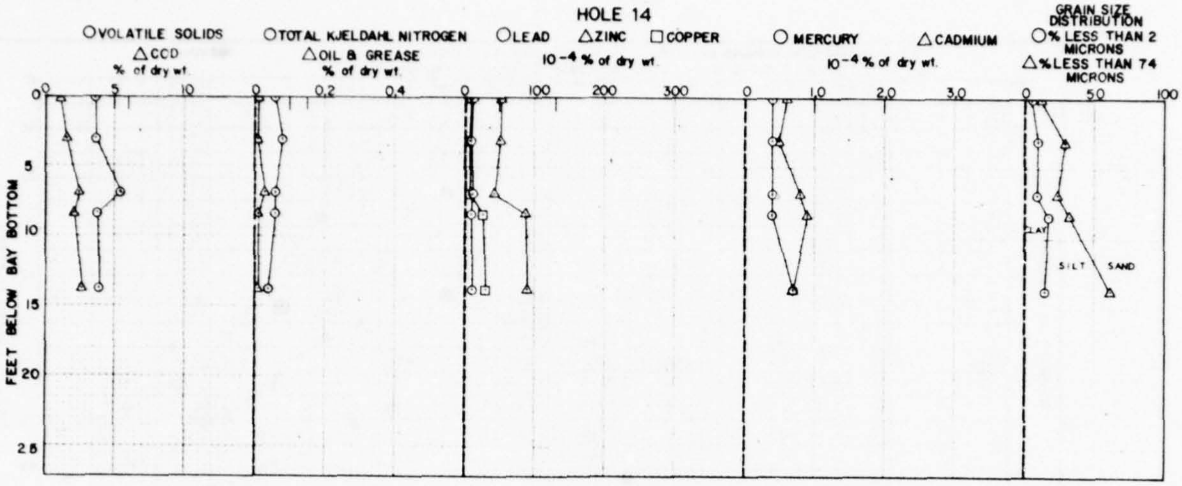
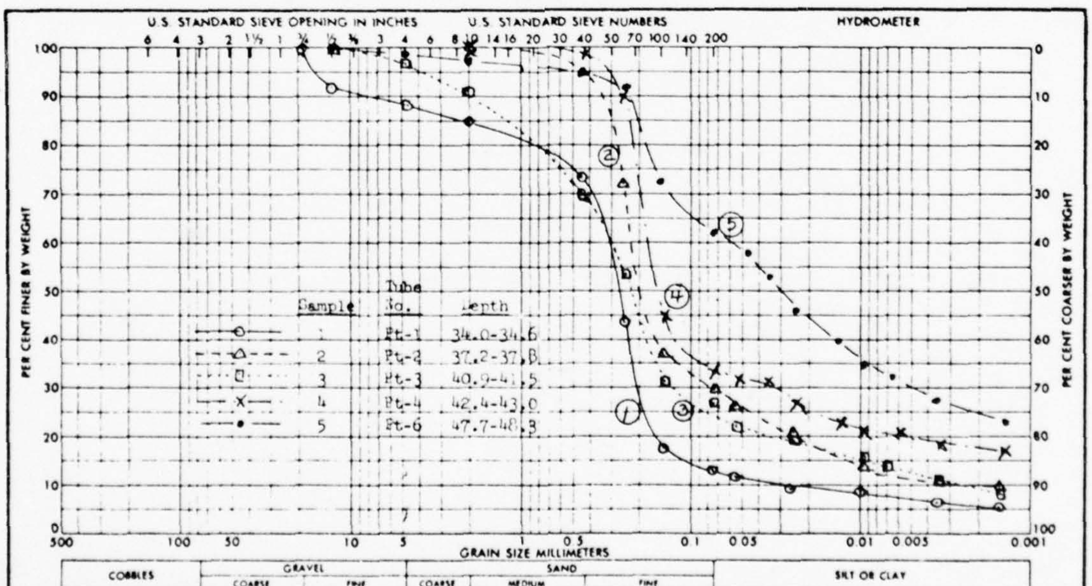


Hole No. 2D-146 (14)

Field Sample No.	PT-1	PT-2	PT-3	PT-4	PT-6
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-1087	PC-1088	PC-1089	PC-1090	PC-1091
Volatile Solids, % of dry wt.	3.7	3.7	5.4	3.8	3.9
C.O.D., % of dry wt.	1.2	1.6	2.5	2.2	2.7
Total Kjeldahl Nitrogen, % of dry wt.	0.06	0.08	0.06	0.06	0.04
Oil and Grease, % of dry wt.	0.01	0.01	0.03	0.01	0.01
Mercury (Hg), 10^{-4} % of dry wt.	0.4	0.4	0.4	0.4	0.7
Lead (Pb), 10^{-4} % of dry wt.	12	10	12	10	11
Zinc (Zn), 10^{-4} % of dry wt.	53	52	43	87	90
Cadmium (Cd), 10^{-4} % of dry wt.	0.6	0.5	0.8	0.9	0.7
Copper (Cu), 10^{-4} % of dry wt.	10	8	7	27	31



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
Pt-1	34.0-36.5		28.8			
Pt-2	36.5-39.0		36.7			
Pt-3	39.0-41.5		39.2			
Pt-4	41.5-44.0		33.8			
Pt-6	46.5-49.0		50.8			

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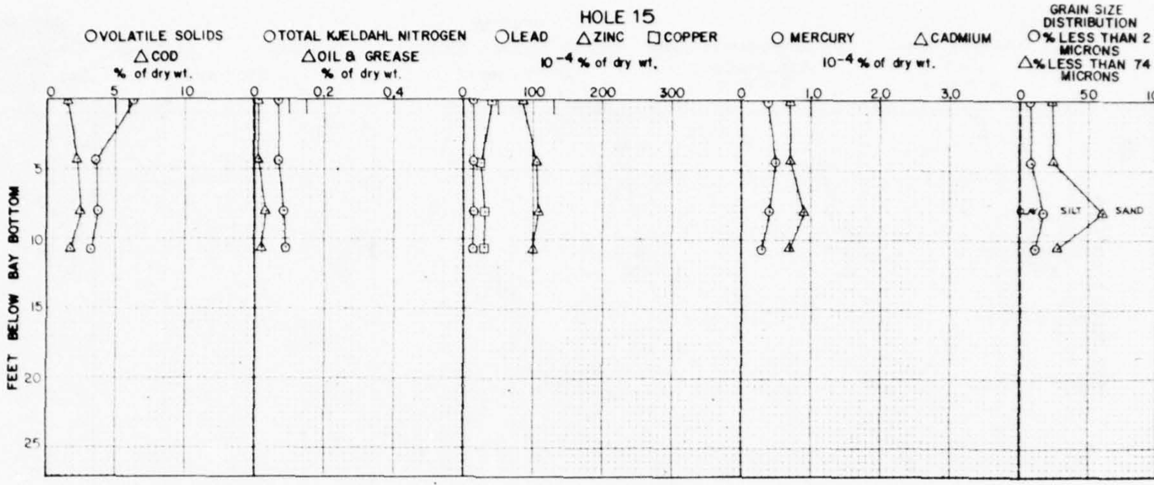
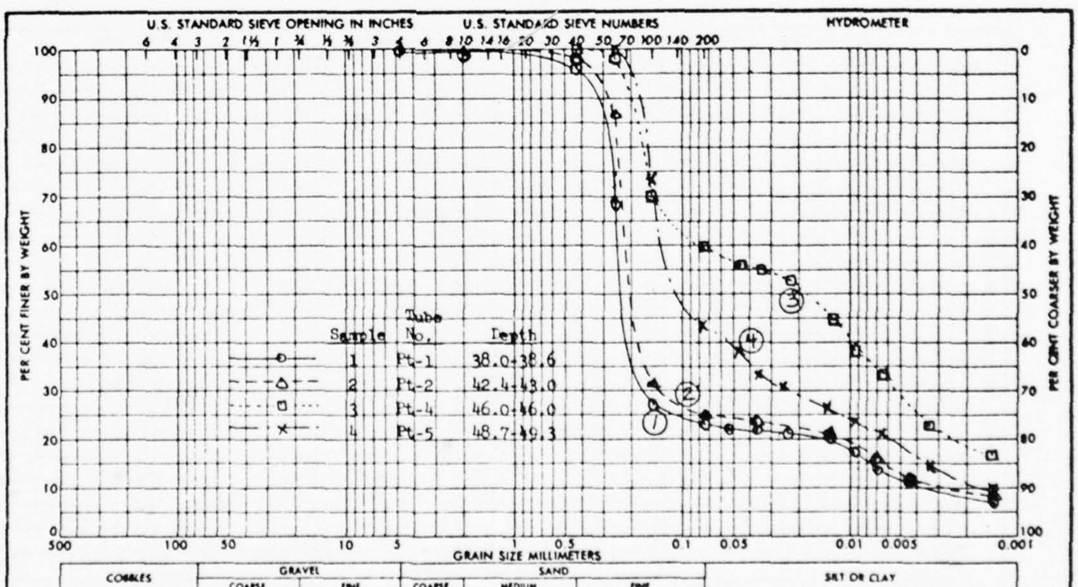


Hole No. 2D-164 (15)

Field Sample No.	PT-1	PT-2	PT-4	PT-5
Laboratory Sample No.	1	2	3	4
Laboratory No.	PC-1100	PC-1101	PC-1102	PC-1103
Volatile Solids, % of dry wt.	6.3	3.6	3.7	3.3
C.O.D., % of dry wt.	1.6	2.3	2.5	1.8
Total Kjeldahl Nitrogen, % of dry wt.	0.07	0.07	0.08	0.09
Oil and Grease, % of dry wt.	0.01	0.01	0.03	0.02
Mercury (Hg), 10^{-4} % of dry wt.	0.4	0.5	0.4	0.3
Lead (Pb), 10^{-4} % of dry wt.	12	14	13	12
Zinc (Zn), 10^{-4} % of dry wt.	84	103	107	100
Cadmium (Cd), 10^{-4} % of dry wt.	0.7	0.7	0.9	0.7
Copper (Cu), 10^{-4} % of dry wt.	40	26	30	30



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
Pt-1	38.0-40.5		44.1			
Pt-2	40.5-43.0		42.0			
Pt-4	45.5-48.0		57.0			
Pt-5	48.0-50.5		39.2			

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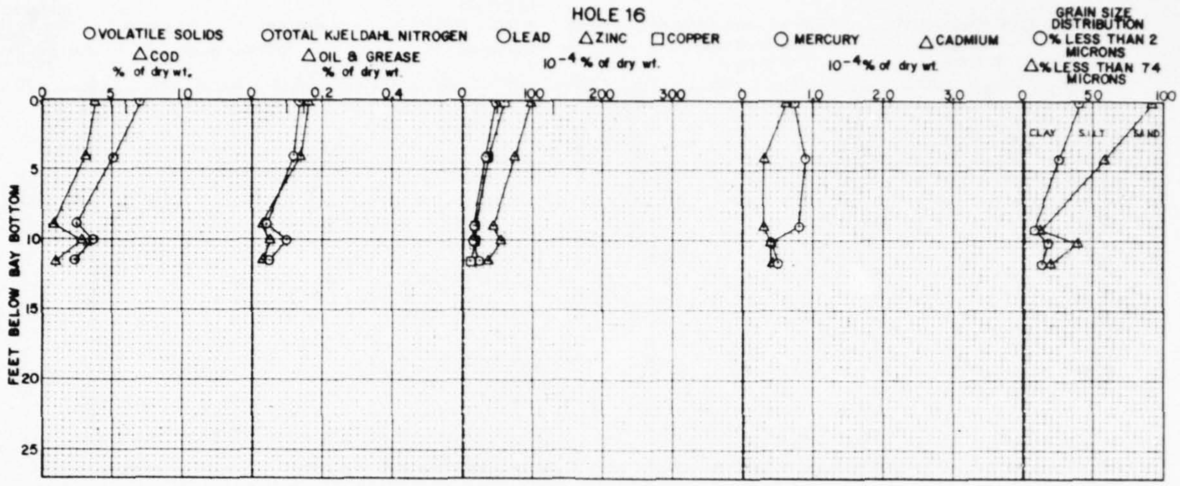
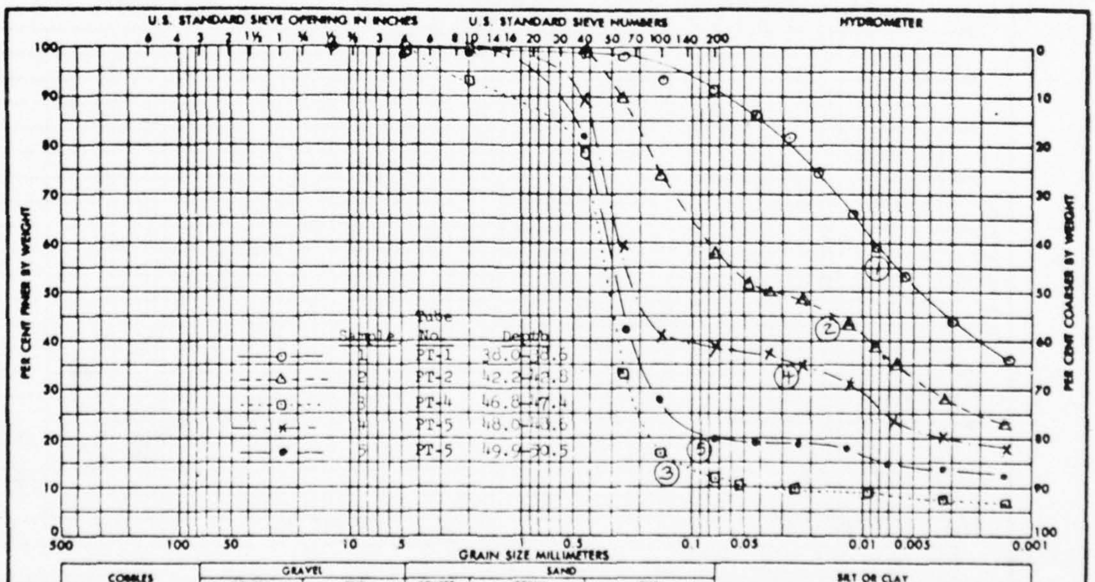


Hole No. 2D-132 (16)

Field Sample No.	PT-1	PT-2	PT-4	PT-5	PT-5
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-1018	PC-1019	PC-1020	PC-1021	PC-1022
Volatile Solids, % of dry wt.	7.0	5.1	2.5	3.6	2.4
C.O.D., % of dry wt.	3.8	3.1	0.9	2.9	1.0
Total Kjeldahl Nitrogen, % of dry wt.	0.13	0.12	0.04	0.10	0.05
Oil and Grease, % of dry wt.	0.16	0.14	0.03	0.05	0.03
Mercury (Hg), 10^{-4} % of dry wt.	0.7	0.9	0.8	0.4	0.5
Lead (Pb), 10^{-4} % of dry wt.	48	31	17	16	21
Zinc (Zn), 10^{-4} % of dry wt.	99	73	42	55	38
Cadmium (Cd), 10^{-4} % of dry wt.	0.6	0.3	0.3	0.4	0.4
Copper (Cu), 10^{-4} % of dry wt.	60	37	18	19	11
	.0031				



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	38.0-40.5		97.4			
PT-2	40.5-43.0		76.7			
PT-4	45.5-48.0		25.9			
PT-5	48.0-50.5		76.3			

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Dredge Material Disposal Study
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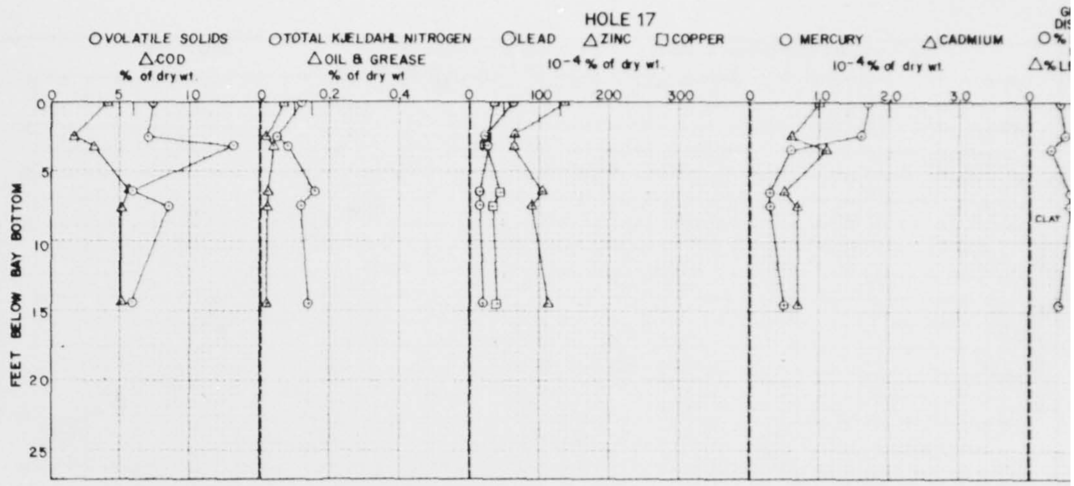

Hole No. 2D-120 (17)

Field Sample No.	PT-1	PT-2	PT-2	PT-3	PT-4
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-960	PC-961	PC-962	PC-963	PC-964
Volatile Solids, % of dry wt.	7.4	7.0	13.1	5.9	8.5
C.O.D., % of dry wt.	4.2	1.7	3.0	5.6	5.1
Total Kjeldahl Nitrogen, % of dry wt.	0.12	0.05	0.08	0.16	0.12
Oil and Grease, % of dry wt.	0.07	0.02	0.04	0.02	0.02
Mercury (Hg), 10^{-4} % of dry wt.	1.7	1.6	0.6	0.3	0.3
Lead (Pb), 10^{-4} % of dry wt.	62	22	28	17	17
Zinc (Zn), 10^{-4} % of dry wt.	139	67	65	106	90
Cadmium (Cd), 10^{-4} % of dry wt.	1.0	0.6	1.1	0.5	0.7
Copper (Cu), 10^{-4} % of dry wt.	37	26	24	45	33

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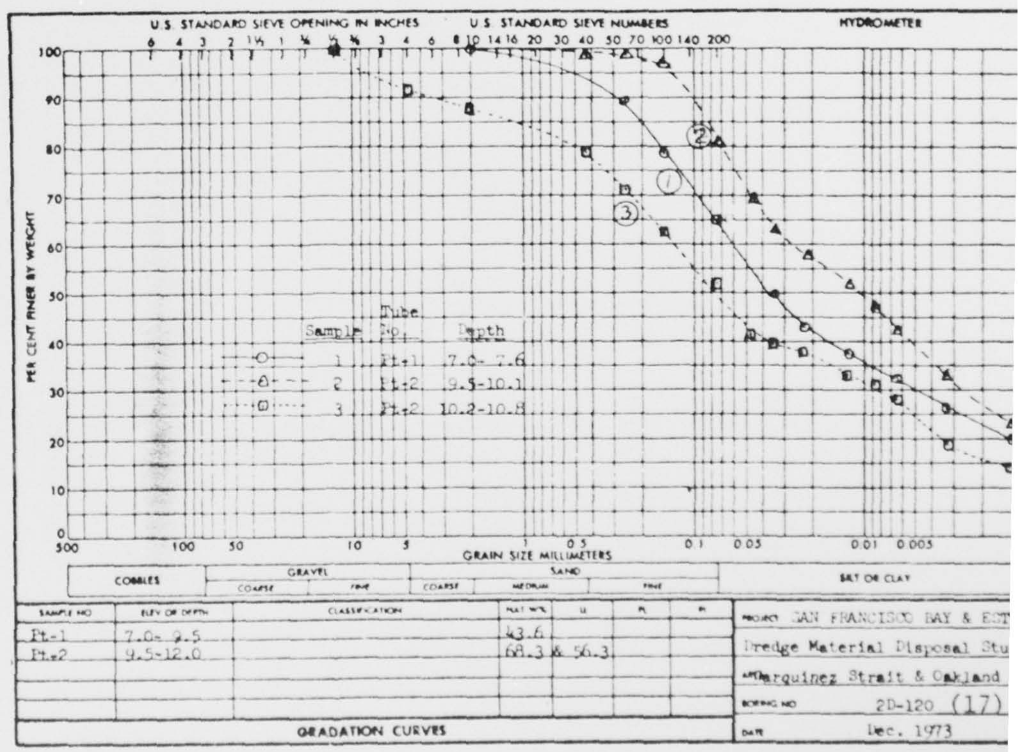

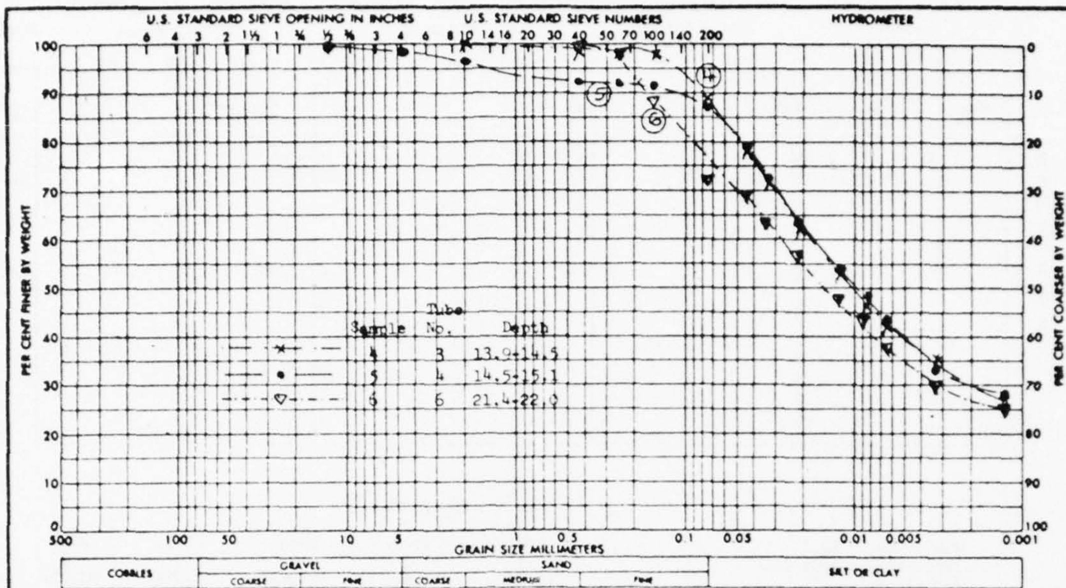

SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
Pt-3	12.0-14.5		80.6			
Pt-4	14.5-17.0		86.3			
Pt-6	19.5-22.0		71.2			

GRADATION CURVES

PROJECT SAN FRANCISCO BAY & ESTUARY
Dredge Material Disposal Study
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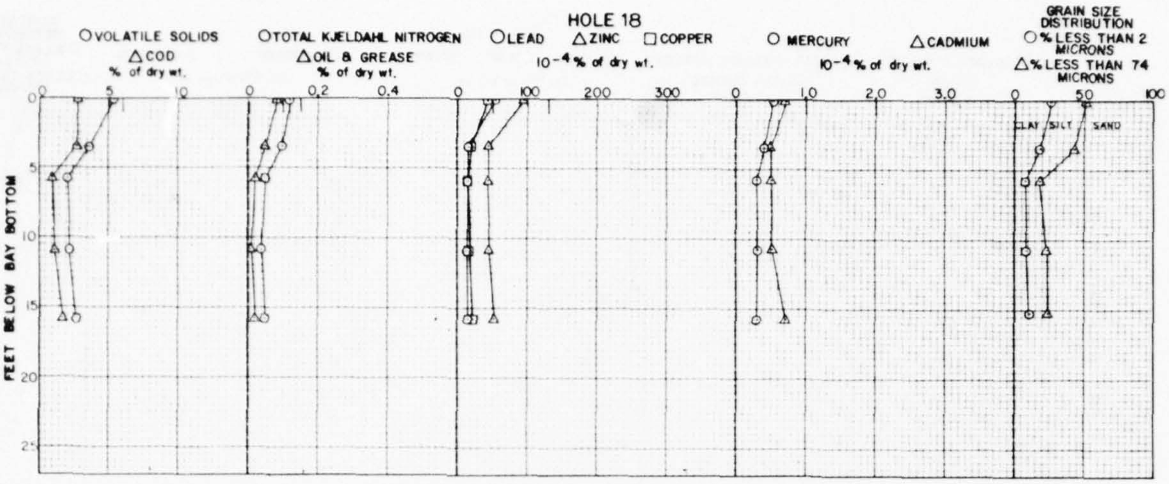
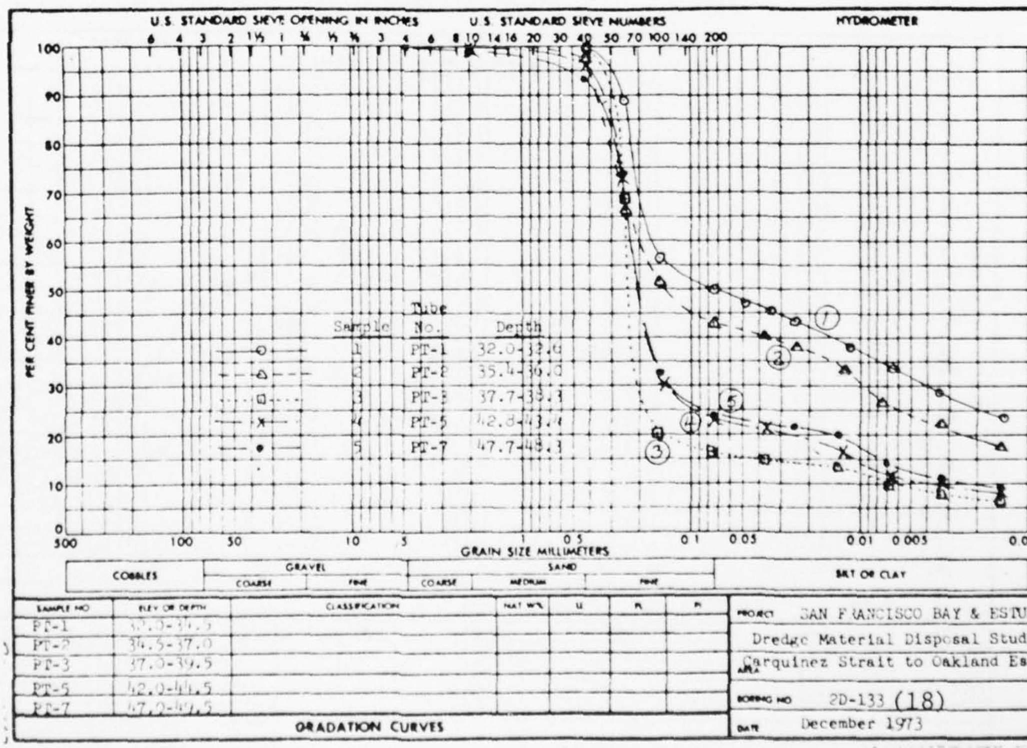
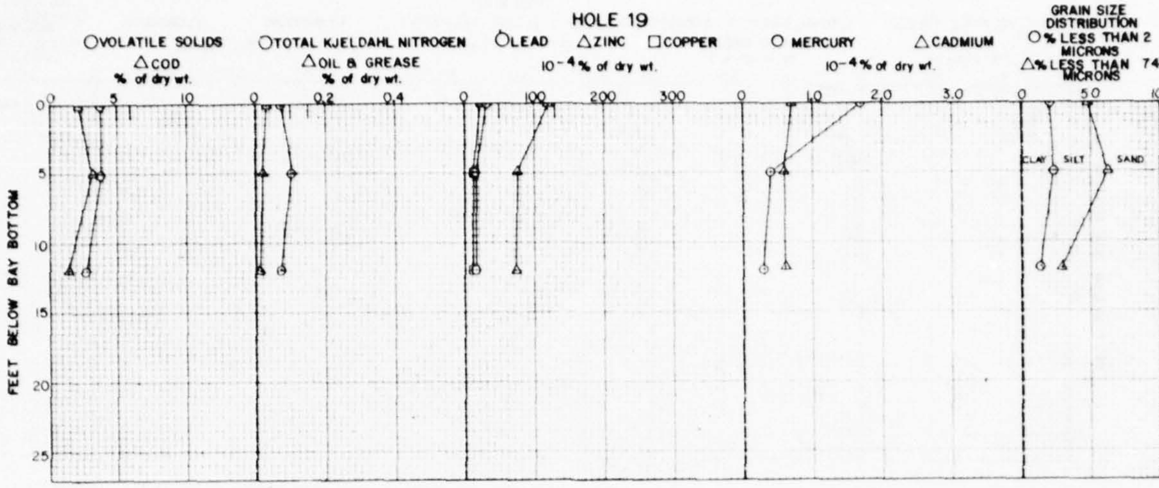
BORING NO 2D-120 (17)
DATE Dec. 1973



Hole No. 2D-133 (18)

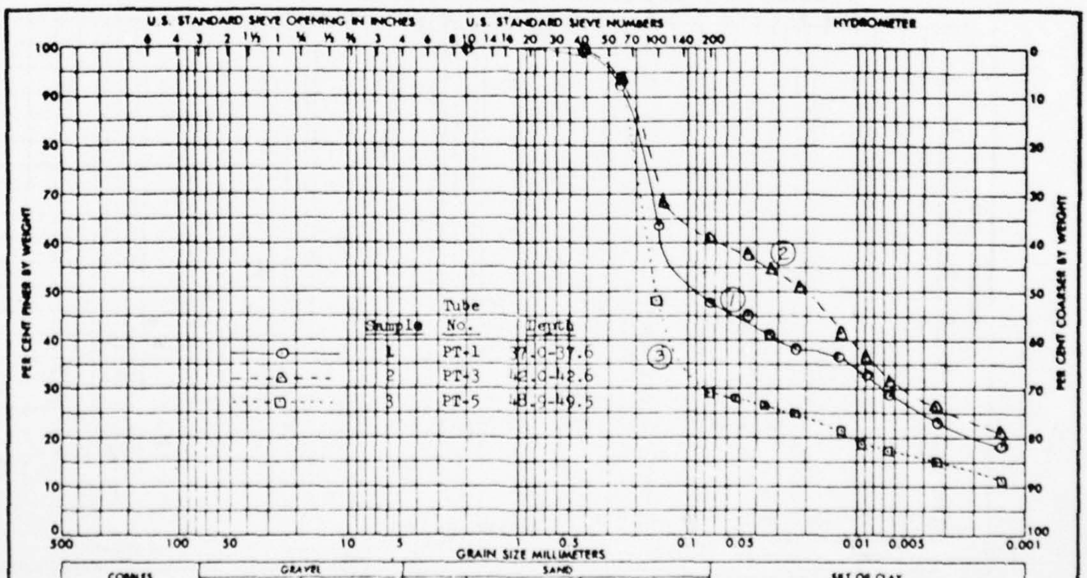
Field Sample No.	PT-1	PT-2	PT-3	PT-5	PT-7
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-1023	PC-1024	PC-1025	PC-1026	PC-1027
Volatile Solids, % of dry wt.	5.3	3.6	2.1	2.2	2.7
C.O.D., % of dry wt.	2.7	2.7	1.0	1.2	1.8
Total Kjeldahl Nitrogen, % of dry wt.	0.12	0.10	0.05	0.04	0.05
Oil and Grease, % of dry wt.	0.08	0.05	0.02	0.01	0.02
Mercury (Hg), 10^{-4} % of dry wt.	0.5	0.4	0.3	0.3	0.3
Lead (Pb), 10^{-4} % of dry wt.	51	16	14	14	14
Zinc (Zn), 10^{-4} % of dry wt.	93	44	44	45	51
Cadmium (Cd), 10^{-4} % of dry wt.	0.7	0.5	0.5	0.5	0.7
Copper (Cu), 10^{-4} % of dry wt.	41	18	14	18	21





Hole No. 2D-127 (19)

Field Sample No.	PT-1	PT-3	PT-5
Laboratory Sample No.	1	2	3
Laboratory No.	PC-996	PC-997	PC-998
Volatile Solids, % of dry wt.	3.7	3.7	2.7
C.O.D., % of dry wt.	2.2	3.2	1.5
Total Kjeldahl Nitrogen, % of dry wt.	0.07	0.11	0.07
Oil and Grease, % of dry wt.	0.03	0.02	0.01
Mercury (Hg), 10^{-4} % of dry wt.	1.7	0.4	0.3
Lead (Pb), 10^{-4} % of dry wt.	32	17	17
Zinc (Zn), 10^{-4} % of dry wt.	120	76	73
Cadmium (Cd), 10^{-4} % of dry wt.	0.7	0.6	0.6
Copper (Cu), 10^{-4} % of dry wt.	22	14	12



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	37.0-39.5		55.6			
PT-3	42.0-44.5		71.8			
PT-5	47.0-49.5		39.7			

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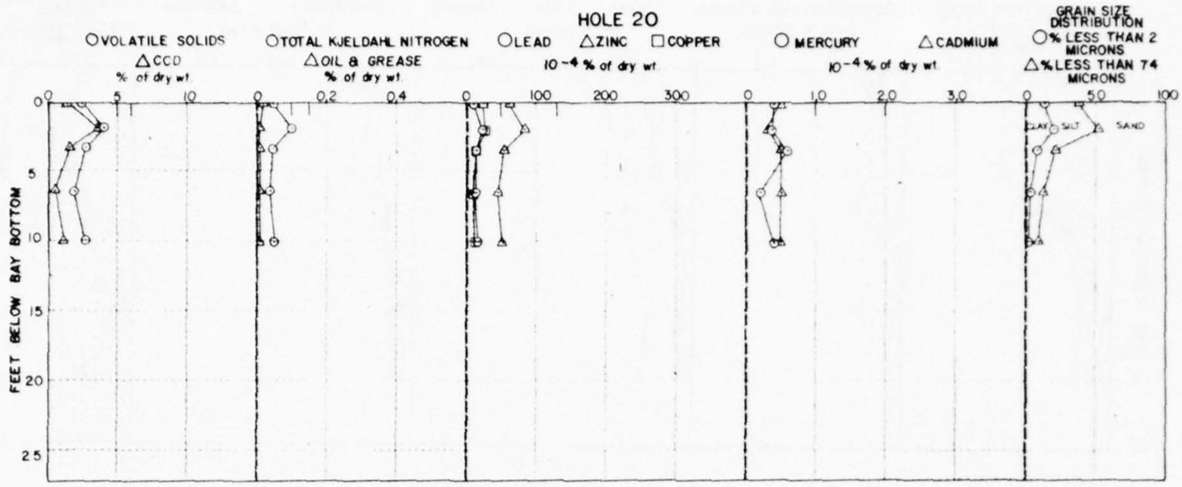
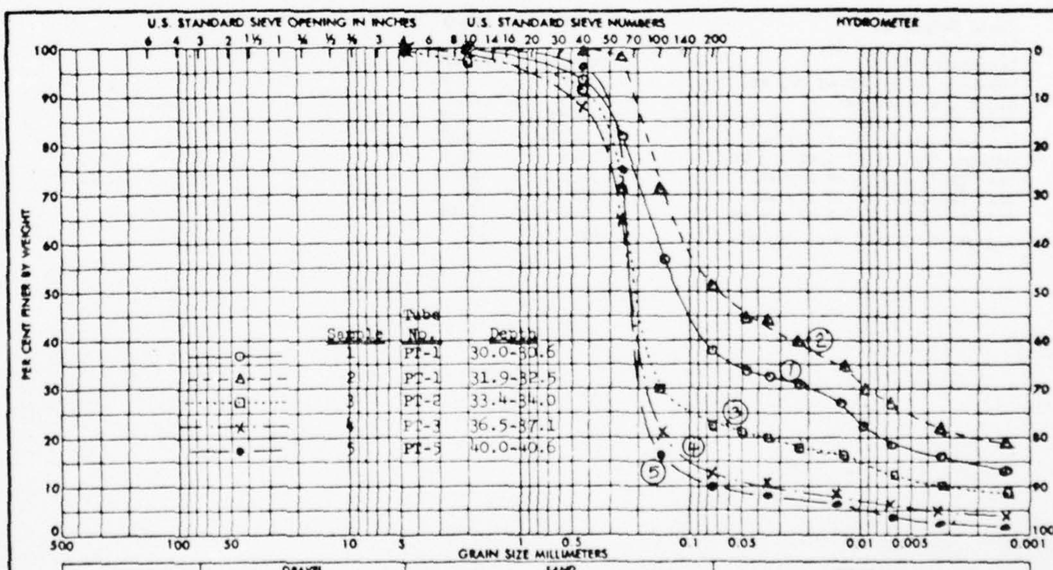


Hole No. 2D-130 (20)

Field Sample No.	PT-1	PT-1	PT-2	PT-3	PT-5
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-1010	PC-1011	PC-1012	PC-1013	PC-1014
Volatile Solids, % of dry wt.	2.4	4.0	2.6	1.9	2.6
C.O.D., % of dry wt.	1.2	3.7	1.5	0.5	1.1
Total Kjeldahl Nitrogen, % of dry wt.	0.05	0.10	0.05	0.04	0.05
Oil and Grease, % of dry wt.	0.02	0.01	0.01-	0.01	0.01
Mercury (Hg), 10^{-4} % of dry wt.	0.4	0.4	0.6	0.2	0.4
Lead (Pb), 10^{-4} % of dry wt.	12	22	17	16	19
Zinc (Zn), 10^{-4} % of dry wt.	61	82	55	48	52
Cadmium (Cd), 10^{-4} % of dry wt.	0.5	0.3	0.5	0.5	0.5
Copper (Cu), 10^{-4} % of dry wt.	24	27	17	12	16



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	30.0-32.5		46.9 & 54.6			
PT-2	32.5-35.0		32.9			
PT-3	35.0-37.5		27.3			
PT-5	40.0-42.5		29.0			

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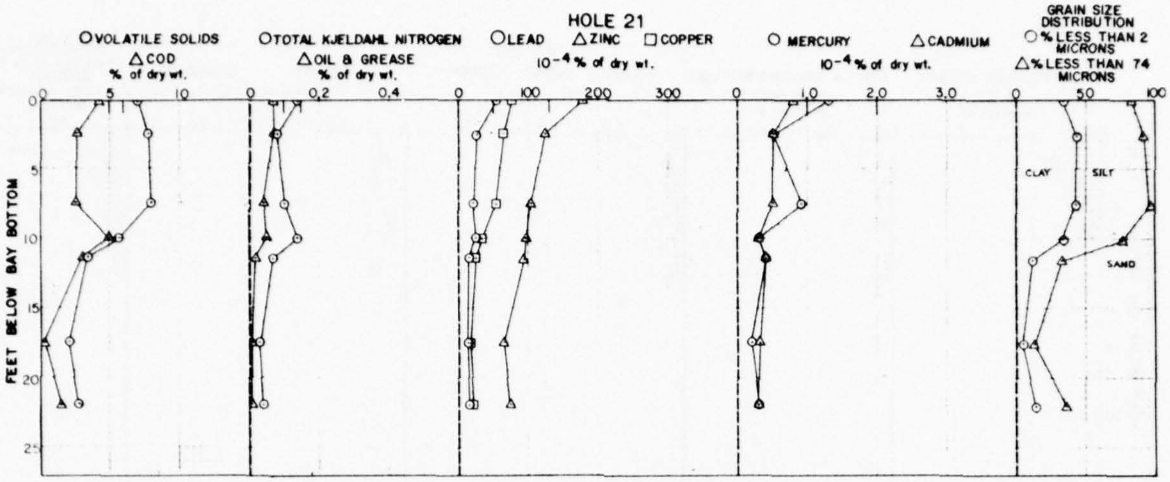
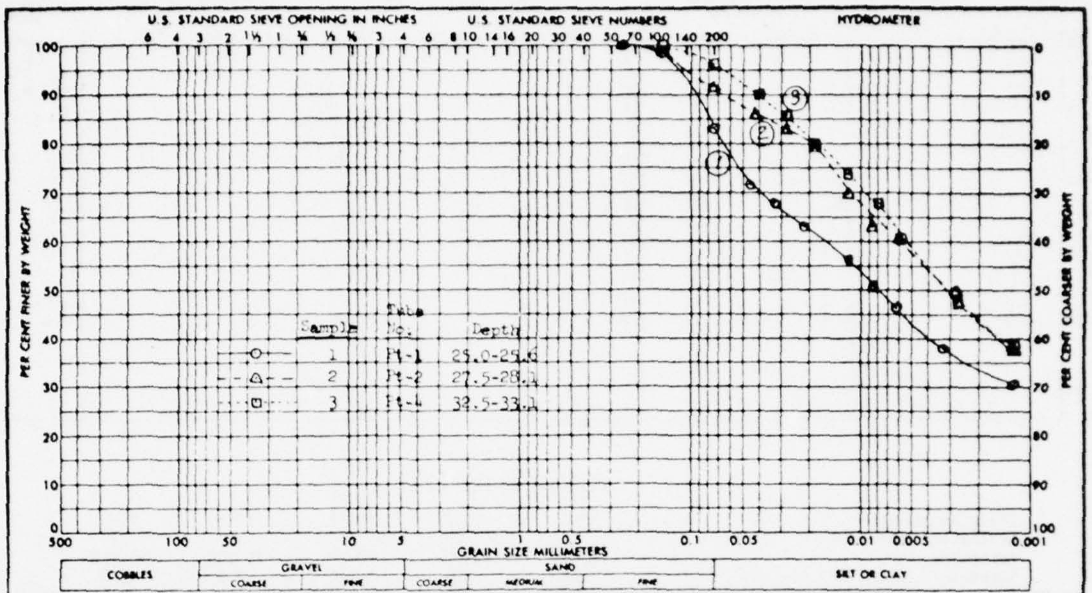


Hole No. 2D-121 (21)

Field Sample No.	PT-1	PT-2	PT-4	PT-5	PT-5
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-966	PC-967	PC-968	PC-969	PC-970
Volatile Solids, % of dry wt.	7.0	7.7	8.0	5.7	3.5
C.O.D., % of dry wt.	4.3	2.6	2.6	5.0	3.1
Total Kjeldahl Nitrogen, % of dry wt.	0.14	0.08	0.10	0.14	0.07
Oil and Grease, % of dry wt.	0.07	0.07	0.04	0.05	0.02
Mercury (Hg), 10^{-4} % of dry wt.	1.3	0.5	0.9	0.3	0.4
Lead (Pb), 10^{-4} % of dry wt.	54	27	20	24	17
Zinc (Zn), 10^{-4} % of dry wt.	179	124	103	99	94
Cadmium (Cd), 10^{-4} % of dry wt.	0.08	0.05	0.05	0.03	0.04
Copper (Cu), 10^{-4} % of dry wt.	78	62	52	32	27
	.008				

Hole No. 2D-121 (21) (Cont'd)

Field Sample No.	PT-8	PT-9
Laboratory Sample No.	6	7
Laboratory No.	PC-971	PC-972
Volatile Solids, % of dry wt.	2.2	2.9
C.O.D., % of dry wt.	0.4	1.6
Total Kjeldahl Nitrogen, % of dry wt.	0.03	0.04
Oil and Grease, % of dry wt.	0.01-	0.01
Mercury (Hg), 10^{-4} % of dry wt.	0.2	0.3
Lead (Pb), 10^{-4} % of dry wt.	12	16
Zinc (Zn), 10^{-4} % of dry wt.	63	72
Cadmium (Cd), 10^{-4} % of dry wt.	0.03	0.03
Copper (Cu), 10^{-4} % of dry wt.	15	21



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
Pt-1	25.0-27.5		93.7			
Pt-2	27.5-30.0		76.5			
Pt-4	32.5-35.0		73.0			

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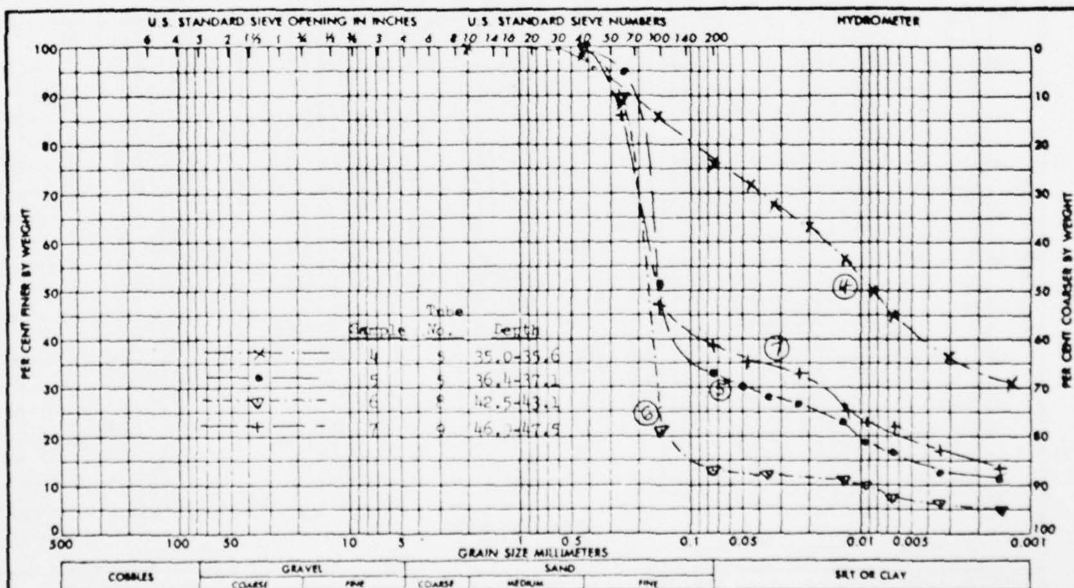

SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
Pt-5	35.0-37.5		75.0 & 42.6			
Pt-8	42.5-45.0		80.0			
Pt-9	45.0-47.5		39.2			

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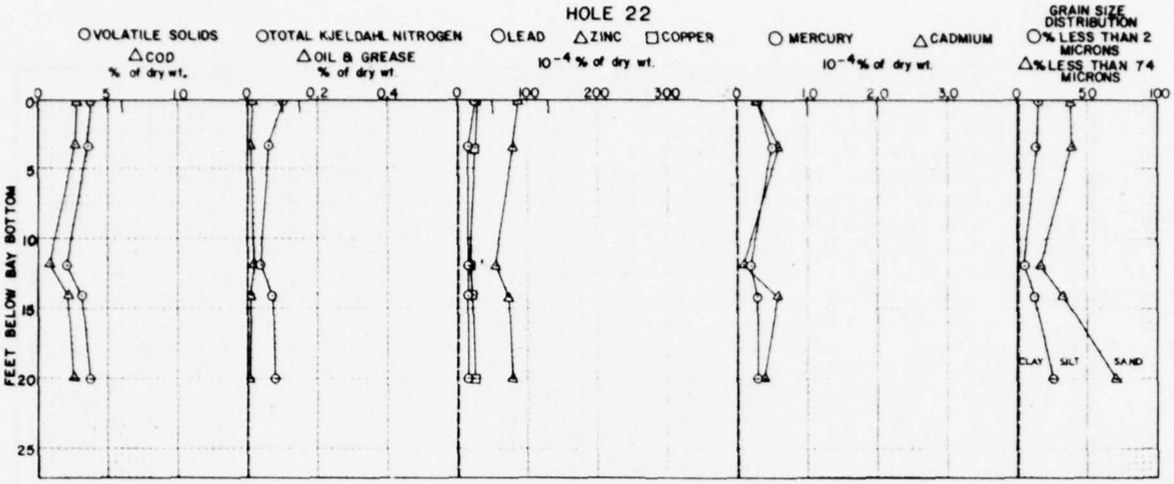
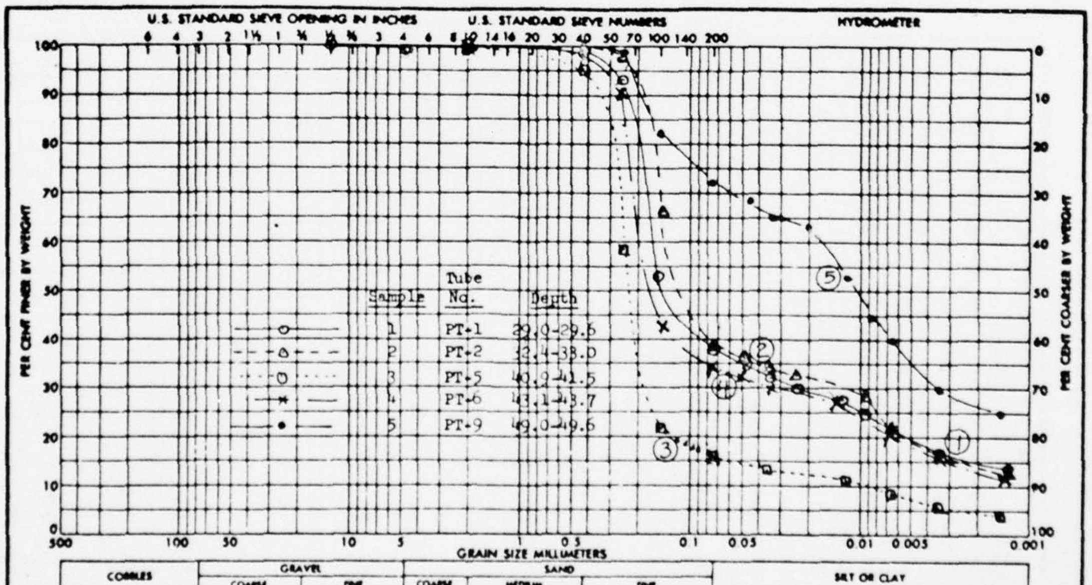


Hole No. 2D-122 (22)

Field Sample No.	PT-1	PT-2	PT-5	PT-6	PT-9
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-973	PC-974	PC-975	PC-976	PC-977
Volatile Solids, % of dry wt.	3.8	3.6	2.2	3.2	3.8
C.O.D., % of dry wt.	2.7	2.6	0.9	2.1	2.6
Total Kjeldahl Nitrogen, % of dry wt.	0.10	0.06	0.04	0.07	0.08
Oil and Grease, % of dry wt.	0.01-	0.01	0.02	0.01	0.01
Mercury (Hg), 10^{-4} % of dry wt.	0.3	0.5	0.2	0.3	0.3
Lead (Pb), 10^{-4} % of dry wt.	21	14	15	14	16
Zinc (Zn), 10^{-4} % of dry wt.	86	79	54	72	80
Cadmium (Cd), 10^{-4} % of dry wt.	0.3	0.6	0.1	0.6	0.4
Copper (Cu), 10^{-4} % of dry wt.	26 .15	26	18	21	27



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	29.0-31.5		51.3			
PT-2	31.5-34.0		48.3			
PT-5	39.0-41.5		30.3			
PT-6	41.5-44.0		40.0			
PT-9	49.0-51.5		51.0			

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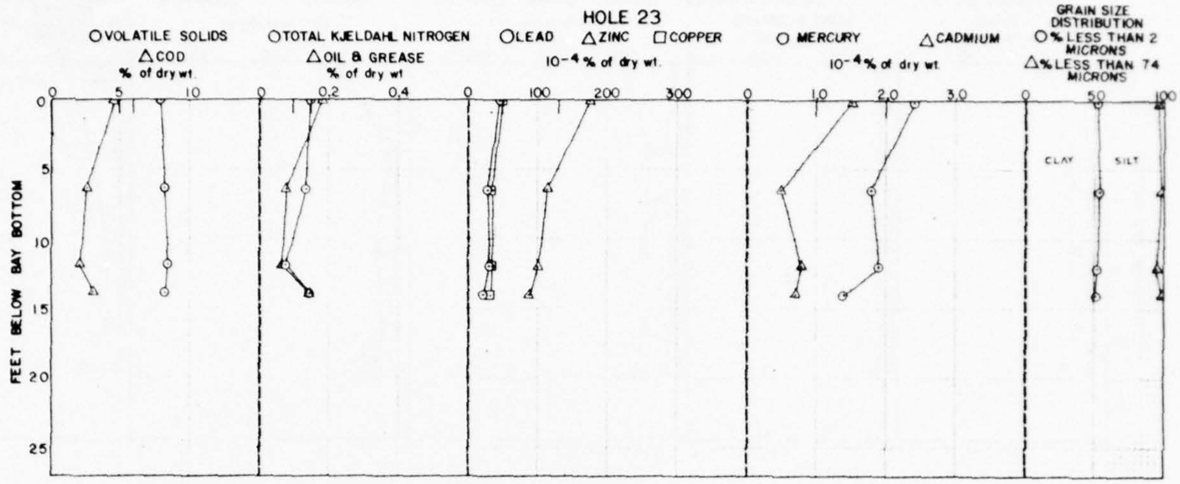
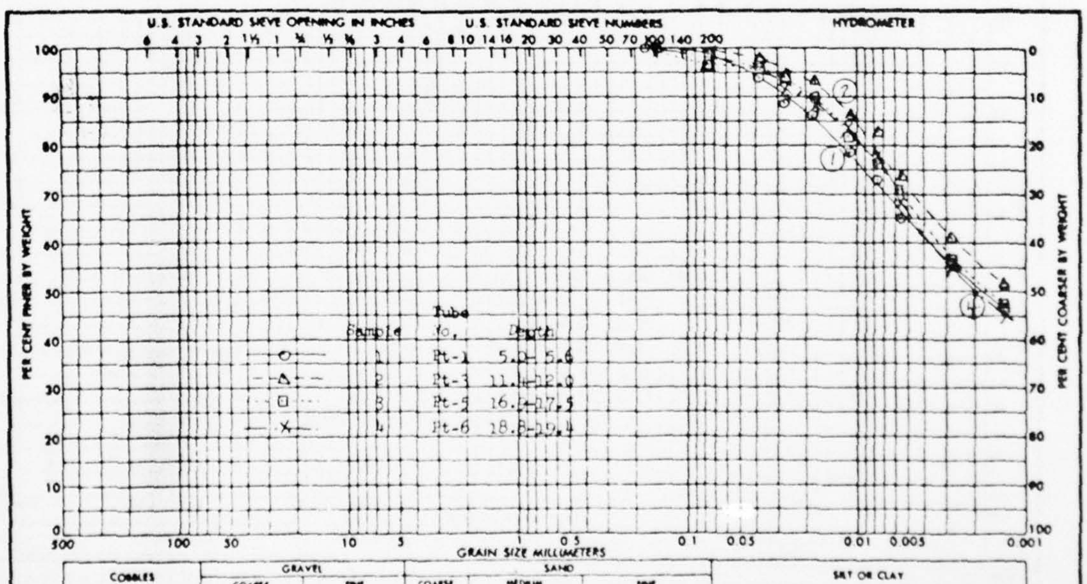


Hole No. 2D-125 (23)

Field Sample No.	PT-1	PT-3	PT-5	PT-6
Laboratory Sample No.	1	2	3	4
Laboratory No.	PC-988	PC-989	PC-990	PC-991
Volatile Solids, % of dry wt.	8.0	8.4	8.5	8.4
C.O.D., % of dry wt.	4.8	2.8	2.3	3.2
Total Kjeldahl Nitrogen, % of dry wt.	0.15	0.14	0.08	0.15
Oil and Grease, % of dry wt.	0.18	0.08	0.07	0.15
Mercury (Hg), 10^{-4} % of dry wt.	2.4	1.8	1.9	1.4
Lead (Pb), 10^{-4} % of dry wt.	48	30	34	24
Zinc (Zn), 10^{-4} % of dry wt.	175	117	101	90
Cadmium (Cd), 10^{-4} % of dry wt.	1.5	0.5	0.8	0.7
Copper (Cu), 10^{-4} % of dry wt.	49	37	38	34



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
Pt-1	5.0- 7.5		91.3			
Pt-3	10.0-12.5		84.3			
Pt-5	15.0-17.5		87.1			
Pt-6	17.5-20.0		86.6			

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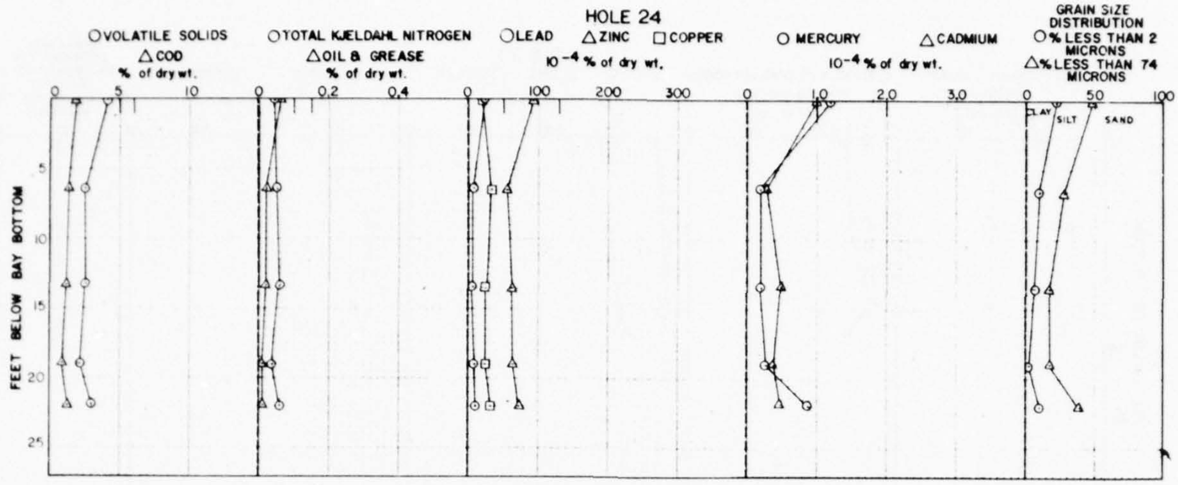
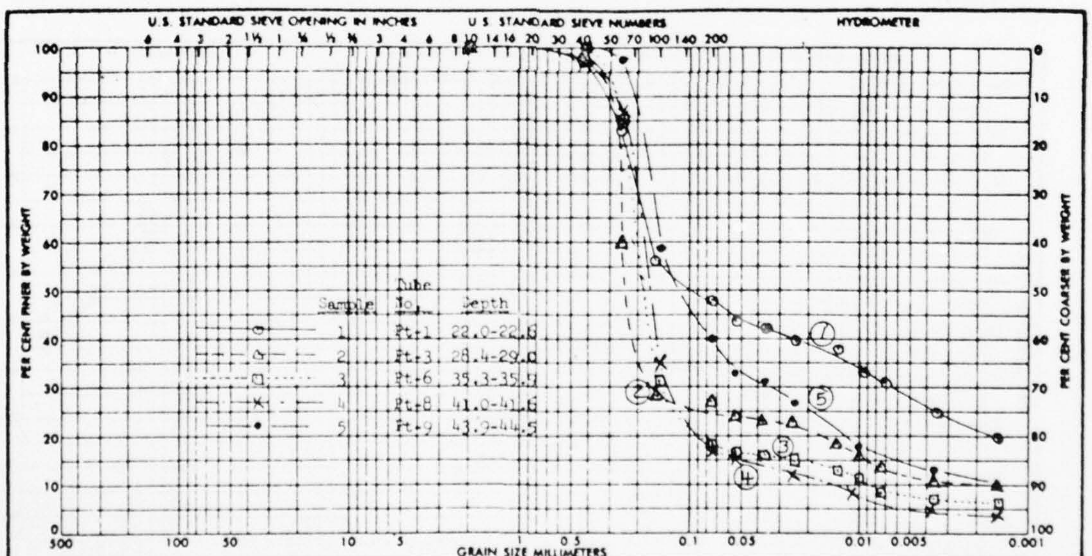


Hole No. 2D-129 (24)

Field Sample No.	PT-1	PT-3	PT-6	PT-8	PT-9
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-1005	PC-1006	PC-1007	PC-1008	PC-1009
Volatile Solids, % of dry wt.	4.2	2.6	2.6	2.3	3.1
C.O.D., % of dry wt.	1.9	1.4	1.3	1.0	1.4
Total Kjeldahl Nitrogen, % of dry wt.	0.04	0.05	0.06	0.04	0.06
Oil and Grease, % of dry wt.	0.06	0.02	0.02	0.01	0.01
Mercury (Hg), 10^{-4} % of dry wt.	1.2	0.2	0.2	0.3	0.9
Lead (Pb), 10^{-4} % of dry wt.	21	8	7	9	10
Zinc (Zn), 10^{-4} % of dry wt.	91	56	62	64	73
Cadmium (Cd), 10^{-4} % of dry wt.	1.0	0.3	0.5	0.4	0.5
Copper (Cu), 10^{-4} % of dry wt.	20	32	24	25	32



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	22.0-24.5		49.3			
PT-3	27.0-29.5		41.0			
PT-6	34.5-37.0		34.0			
PT-8	39.5-42.0		30.3			
PT-9	42.0-44.5		40.7			

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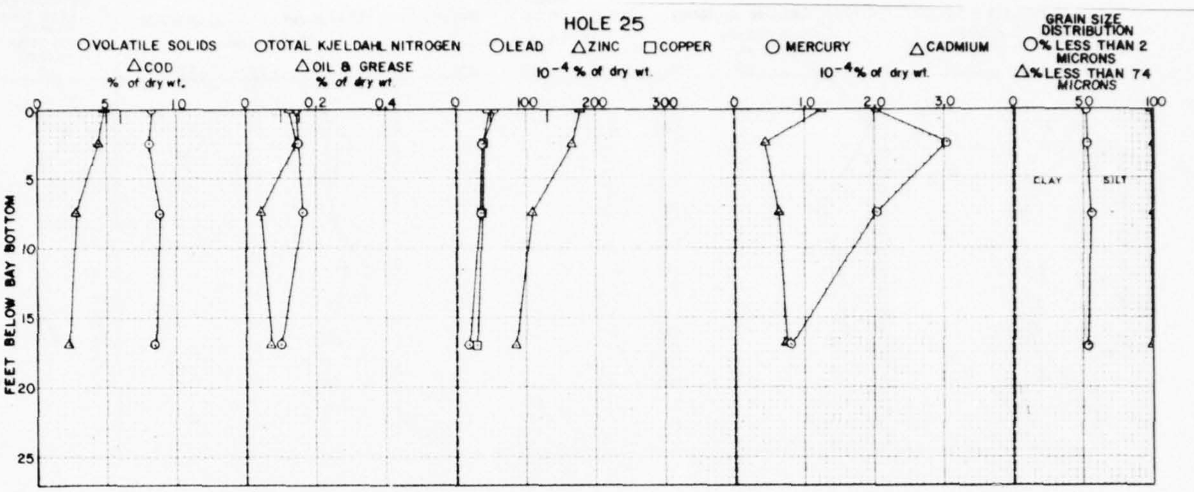

Hole No. 2D-126 (25)

Field Sample No.	PT-1	PT-2	PT-4	PT-7
Laboratory Sample No.	1	2	3	4
Laboratory No.	PC-992	PC-993	PC-994	PC-995
Volatile Solids, % of dry wt.	8.2	8.0	8.9	8.5
C.O.D., % of dry wt.	4.9	4.4	2.9	2.4
Total Kjeldahl Nitrogen, % of dry wt.	0.14	0.15	0.16	0.10
Oil and Grease, % of dry wt.	0.12	0.14	0.04	0.07
Mercury (Hg), 10^{-4} % of dry wt.	2.0	3.0	2.0	0.8
Lead (Pb), 10^{-4} % of dry wt.	53	38	32	19
Zinc (Zn), 10^{-4} % of dry wt.	179	166	109	86
Cadmium (Cd), 10^{-4} % of dry wt.	1.2	0.4	0.6	0.7
Copper (Cu), 10^{-4} % of dry wt.	46	39	34	30

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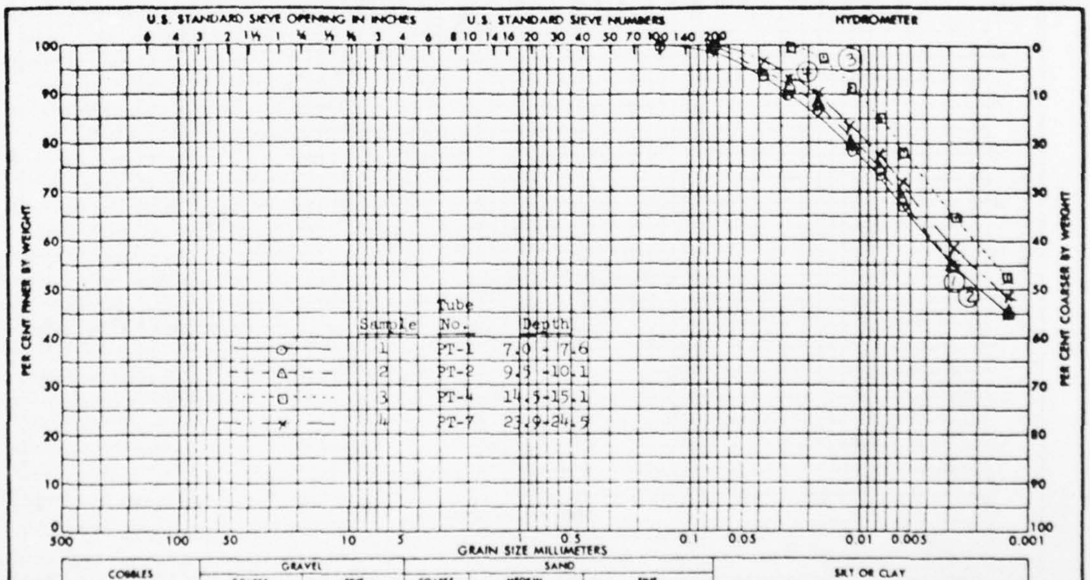

SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	7.0 - 9.5		88.7			
PT-2	9.5 -12.0		100.0			
PT-4	14.5-17.0		95.2			
PT-7	22.5-24.5		80.3			

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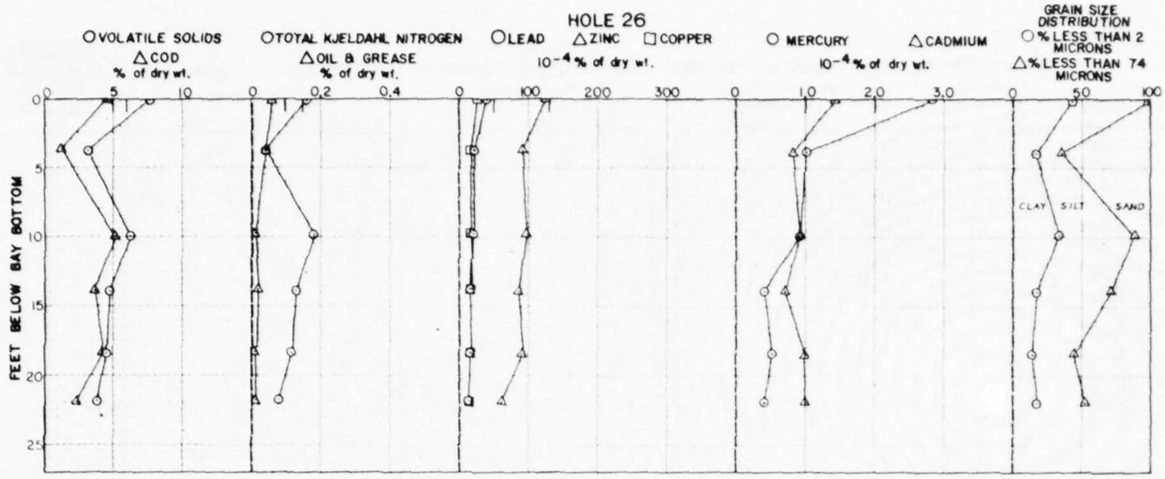
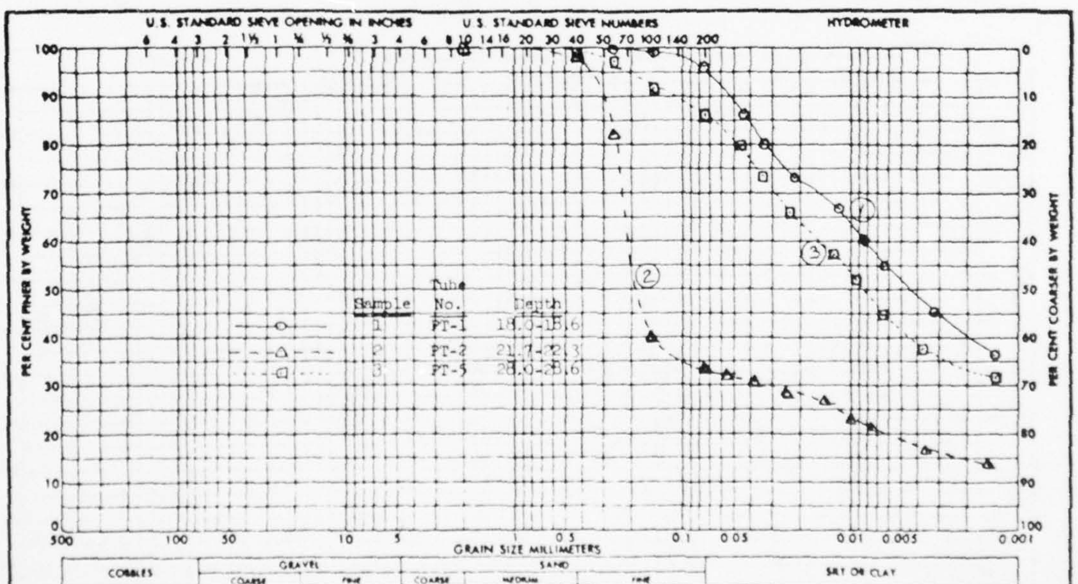


Hole No. 2D-128 (26)

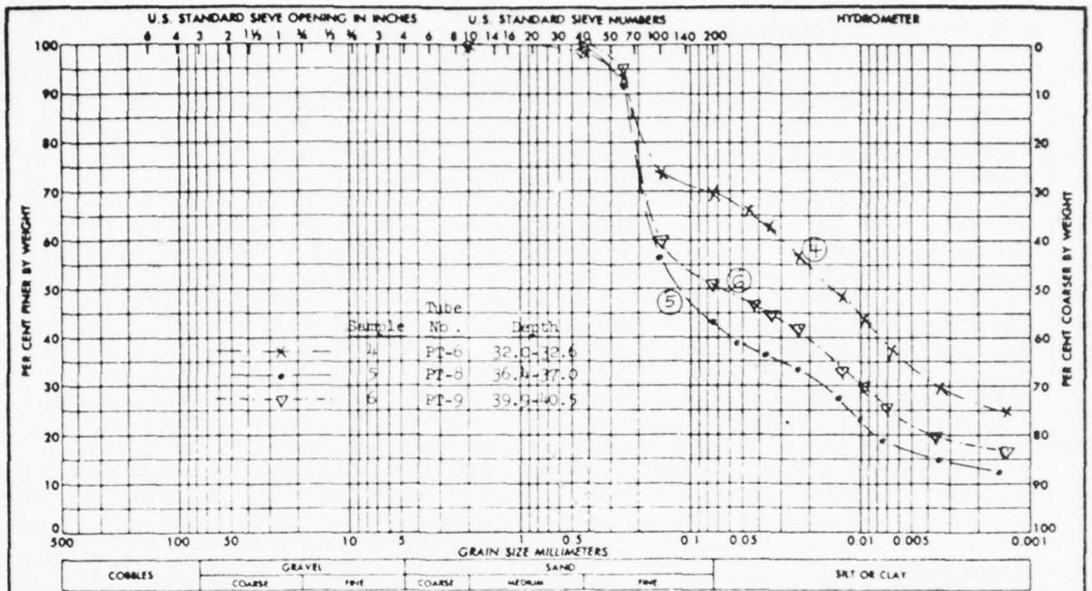
Field Sample No.	PT-1	PT-2	PT-5	PT-6	PT-8	PT-9
Laboratory Sample No.	1	2	3	4	5	6
Laboratory No.	PC-999	PC-1000	PC-1001	PC-1002	PC-1003	PC-1004
Volatile Solids, % of dry wt.	7.7	3.2	6.2	4.8	4.6	3.8
C.O.D., % of dry wt.	4.8	1.3	5.2	3.7	4.4	2.5
Total Kjeldahl Nitrogen, % of dry wt.	0.16	0.04	0.18	0.13	0.12	0.08
Oil and Grease, % of dry wt.	0.06	0.04	0.01	0.02	0.01-	0.01-
Mercury (Hg), 10^{-4} % of dry wt.	2.8	1.0	0.9	0.4	0.5	0.4
Lead (Pb), 10^{-4} % of dry wt.	39	20	20	15	17	13
Zinc (Zn), 10^{-4} % of dry wt.	126	90	98	86	91	61
Cadmium (Cd), 10^{-4} % of dry wt.	1.4	0.8	0.9	0.7	1.0	1.0
Copper (Cu), 10^{-4} % of dry wt.	26 .006	15	17	18	18	14



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	18.0-20.5		95.6			
PT-2	20.5-23.0		43.8			
PT-5	28.0-30.5		86.6			

GRADATION CURVES

PROJECT SAN FRANCISCO BAY & ESTUARY
Dredge Material Disposal Study
AREA Carquinez Strait to Oakland Estuary
BORING NO 2D-128 (26)
DATE December 1973



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-6	30.5-33.0		71.9			
PT-8	35.5-38.0		48.9			
PT-9	38.0-40.5		53.1			

GRADATION CURVES

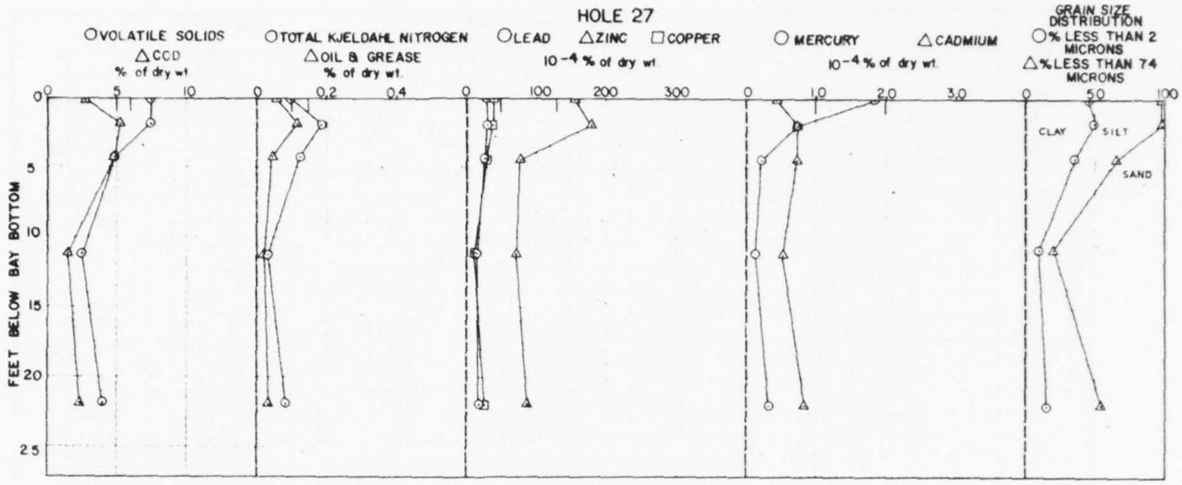
PROJECT SAN FRANCISCO BAY & ESTUARY

Dredge Material Disposal Study

AREA Carquinez Strait to Oakland Estuary

BORING NO 2D-128 (26)

DATE December 1973



Hole No. 2D-124 (27)

Field Sample No.	PT-1	PT-1	PT-2	PT-5	PT-9
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-983	PC-984	PC-985	PC-986	PC-987
Volatile Solids, % of dry wt.	7.9	7.9	4.8	2.5	4.0
C.O.D., % of dry wt.	2.6	5.1	4.8	1.5	2.4
Total Kjeldahl Nitrogen, % of dry wt.	0.09	0.18	0.12	0.03	0.08
Oil and Grease, % of dry wt.	0.05	0.11	0.04	0.02	0.03
Mercury (Hg), 10^{-4} % of dry wt.	1.8	0.7	0.2	0.1	0.3
Lead (Pb), 10^{-4} % of dry wt.	28	30	24	14	18
Zinc (Zn), 10^{-4} % of dry wt.	152	176	75	70	87
Cadmium (Cd), 10^{-4} % of dry wt.	0.4	0.7	0.7	0.5	0.8
Copper (Cu), 10^{-4} % of dry wt.	39	36	26	13	25
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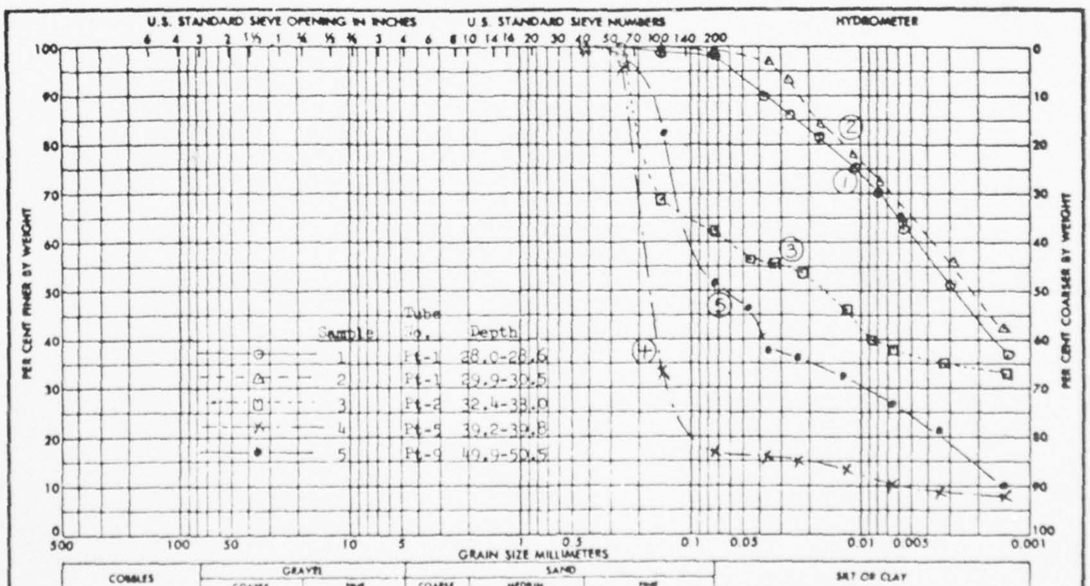

SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
Pt-1	28.0-30.5		82.0 & 110.6			
Pt-2	30.5-33.0		68.9			
Pt-5	38.0-40.5		35.5			
Pt-9	48.0-50.5		42.8			

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GRADATION CURVES

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DREDGE DISPOSAL STUDY. SAN FRANCISCO BAY AND ESTUARY. APPENDIX --ETC(U)
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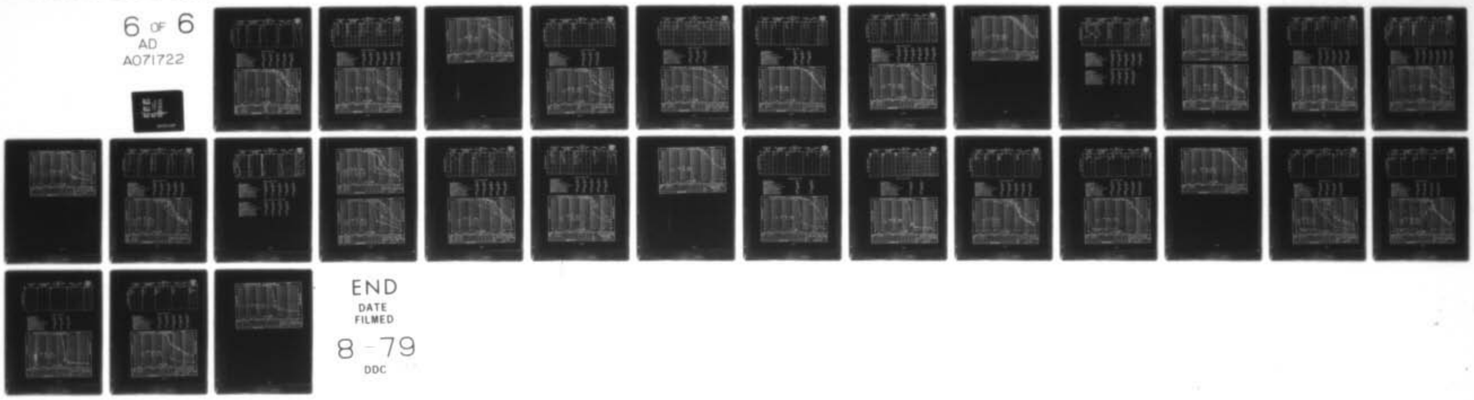

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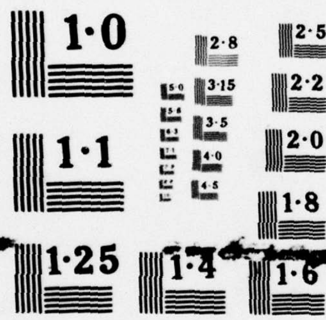
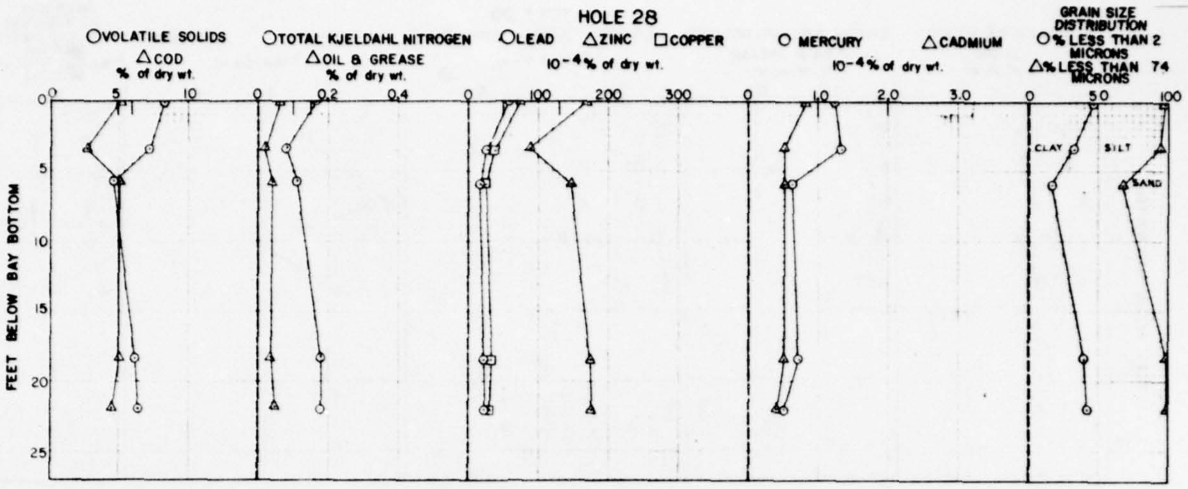


NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART



Hole No. 2D-123 (28)

Field Sample No.	PT-1	PT-2	PT-3	PT-8	PT-9
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-978	PC-979	PC-980	PC-981	PC-982
Volatile Solids, % of dry wt.	8.4	7.7	4.8	6.2	6.5
C.O.D., % of dry wt.	5.1	2.8	5.1	5.1	4.6
Total Kjeldahl Nitrogen, % of dry wt.	0.17	0.08	0.11	0.18	0.18
Oil and Grease, % of dry wt.	0.06	0.02	0.04	0.04	0.05
Mercury (Hg), 10^{-4} % of dry wt.	1.2	1.3	0.6	0.7	0.5
Lead (Pb), 10^{-4} % of dry wt.	59	27	15	21	21
Zinc (Zn), 10^{-4} % of dry wt.	169	89	146	173	175
Cadmium (Cd), 10^{-4} % of dry wt.	0.8	0.5	0.5	0.5	0.4
Copper (Cu), 10^{-4} % of dry wt.	71	37	25	31	30

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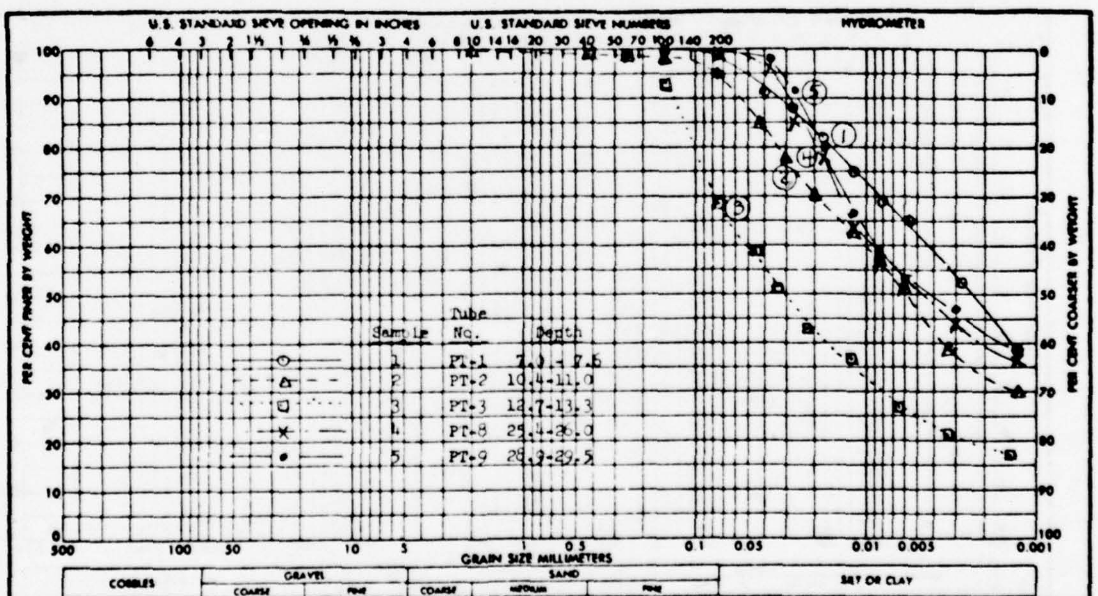

SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	7.0 - 9.5		112.0			
PT-2	9.5 -12.0		81.3			
PT-3	12.0-14.5		69.0			
PT-8	24.5-27.0		79.0			
PT-9	27.0-29.5		82.0			

GRADATION CURVES

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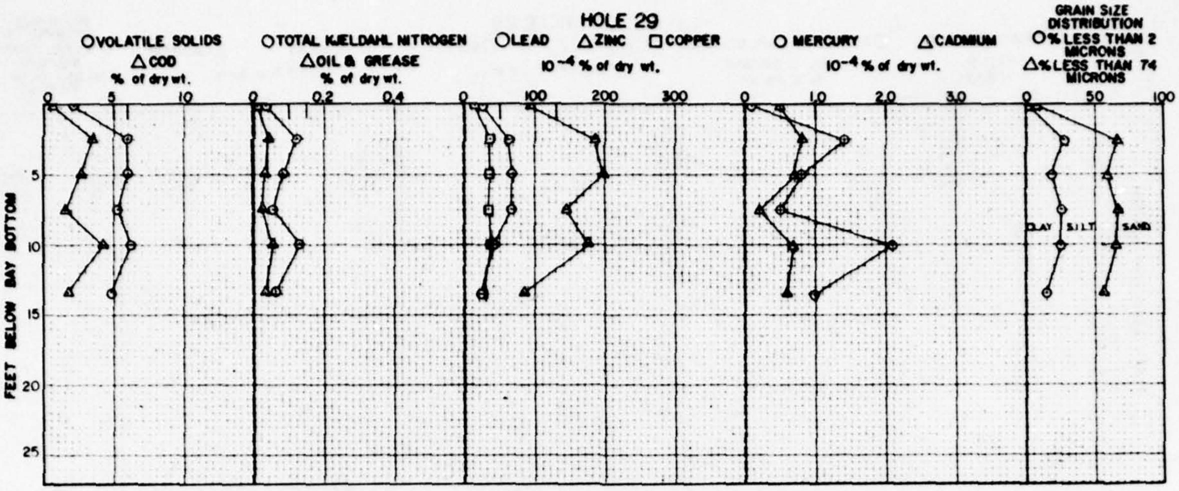

Hole No. 2D-119 (29)

Field Sample No.	PT-1	PT-2	PT-3	PT-4	PT-5	PT-6
Laboratory Sample No.	1	2	3	4	5	6
Laboratory No.	PC-948	PC-949	PC-950	PC-951	PC-952	PC-953
Volatile Solids, % of dry wt.	2.1	6.0	6.0	5.3	6.4	4.9
C.O.D., % of dry wt.	0.6	3.5	2.6	1.5	4.2	1.7
Total Kjeldahl Nitrogen, % of dry wt.	0.03	0.12	0.08	0.05	0.13	0.06
Oil and Grease, % of dry wt.	0.01-	0.04	0.03	0.02	0.05	0.03
Mercury (Hg), 10^{-4} % of dry wt.	0.1	1.4	0.8	0.5	2.1	1.0
Lead (Pb), 10^{-4} % of dry wt.	24	61	63	67	40	22
Zinc (Zn), 10^{-4} % of dry wt.	93	182	197	143	173	84
Cadmium (Cd), 10^{-4} % of dry wt.	0.5	0.8	0.7	0.2	0.7	0.6
Copper (Cu), 10^{-4} % of dry wt.	13	37	35	32	37	24

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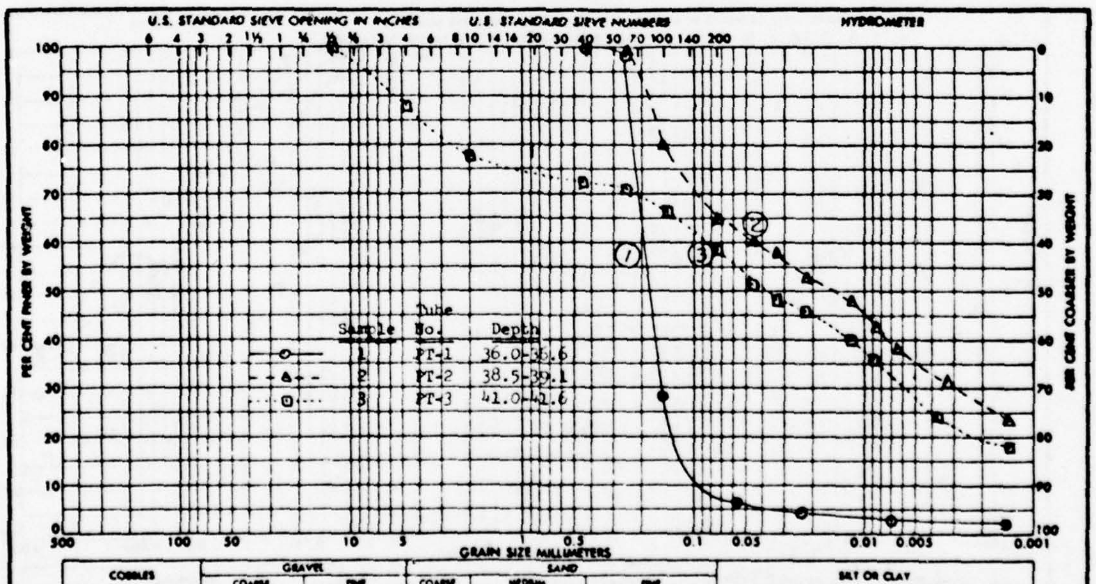
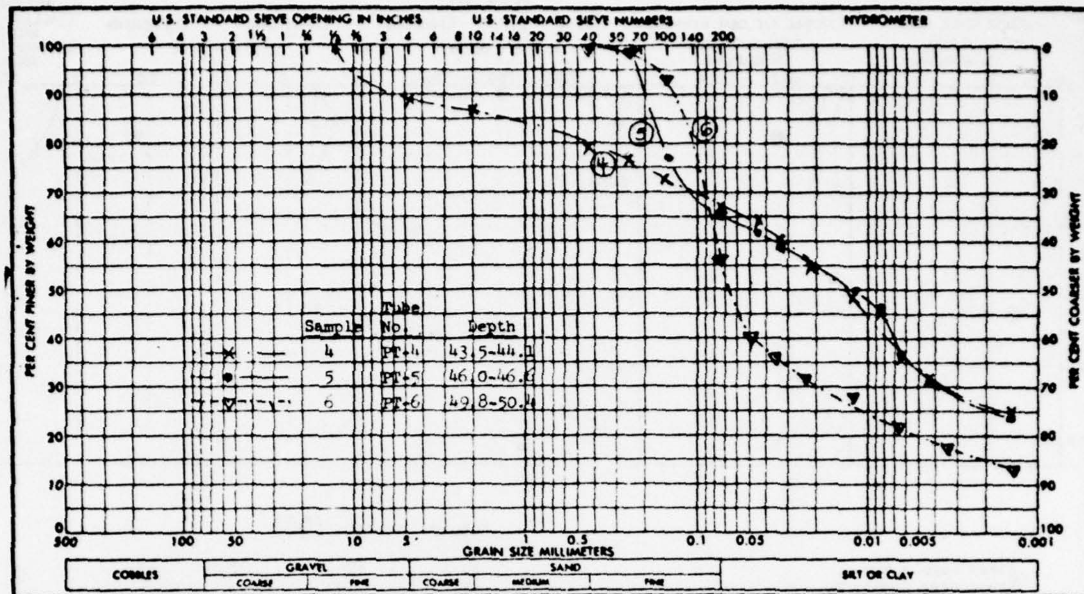


SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	36.0-38.5		29.8			
PT-2	38.5-41.0		66.9			
PT-3	41.0-43.5		35.6			

GRADATION CURVES

PROJECT: SAN FRANCISCO BAY & ESTUARY Dredge Material Disposal Study
AREA: Carquinez Strait to Oakland Estuary
BORING NO: 2D-119 (29)
DATE: December 1973



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-4	43.5-46.0		29.1			
PT-5	46.0-48.5		97.1			
PT-6	48.5-51.0		68.3			

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Dredge Material Disposal Study

AREA Carquinez Strait to Oakland Estuary

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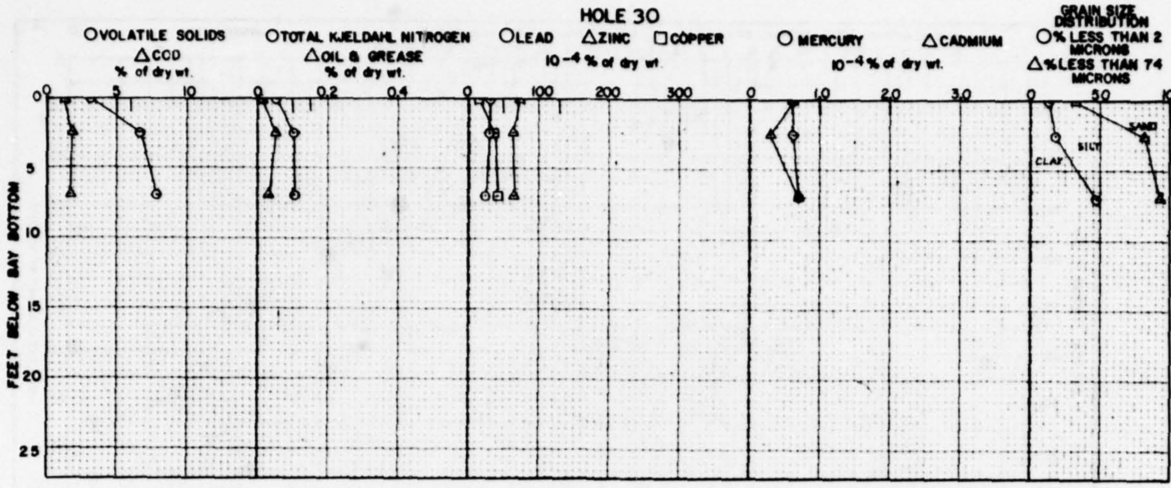
GRADATION CURVES



Hole No. 2D-131 (30)

Field Sample No.	PT-1	PT-2	PT-3
Laboratory Sample No.	1	2	3
Laboratory No.	PC-1015	PC-1016	PC-1017
Volatile Solids, % of dry wt.	3.1	6.6	7.8
C.O.D., % of dry wt.	1.2	1.8	1.7
Total Kjeldahl Nitrogen, % of dry wt.	0.05	0.10	0.11
Oil and Grease, % of dry wt.	0.01	0.05	0.03
Mercury (Hg), 10^{-4} % of dry wt.	0.6	0.6	0.7
Lead (Pb), 10^{-4} % of dry wt.	30	30	27
Zinc (Zn), 10^{-4} % of dry wt.	73	62	65
Cadmium (Cd), 10^{-4} % of dry wt.	0.6	0.3	0.7
Copper (Cu), 10^{-4} % of dry wt.	18	39	41

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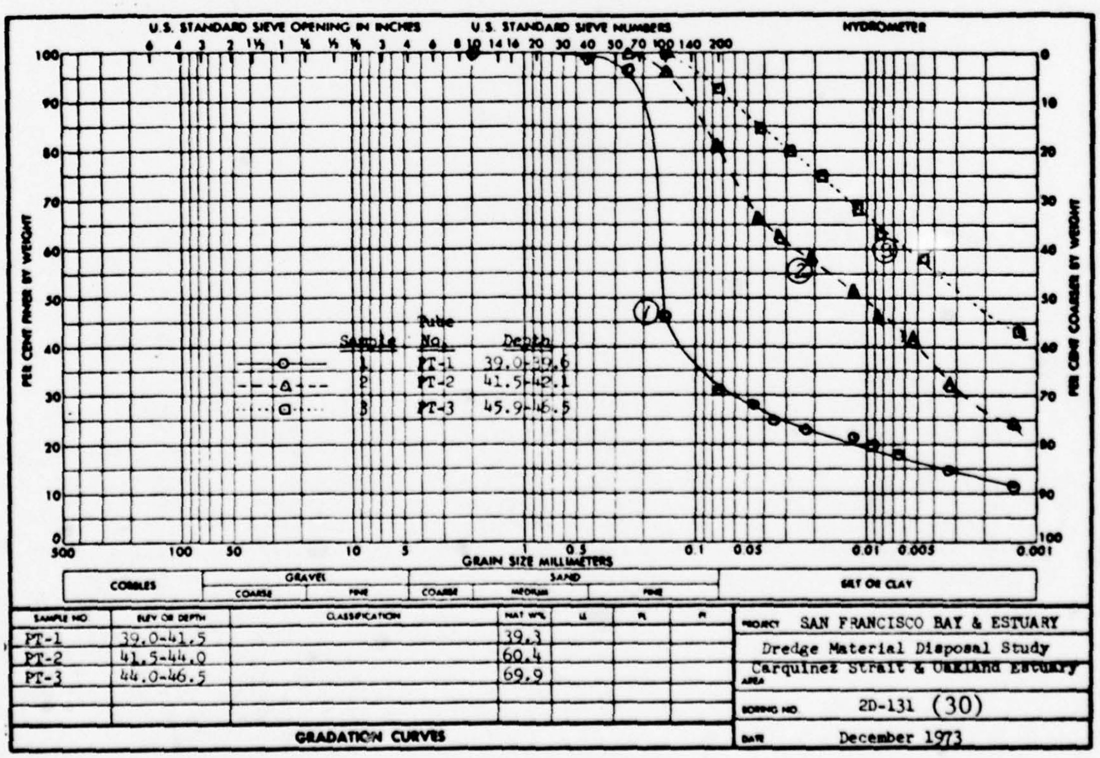

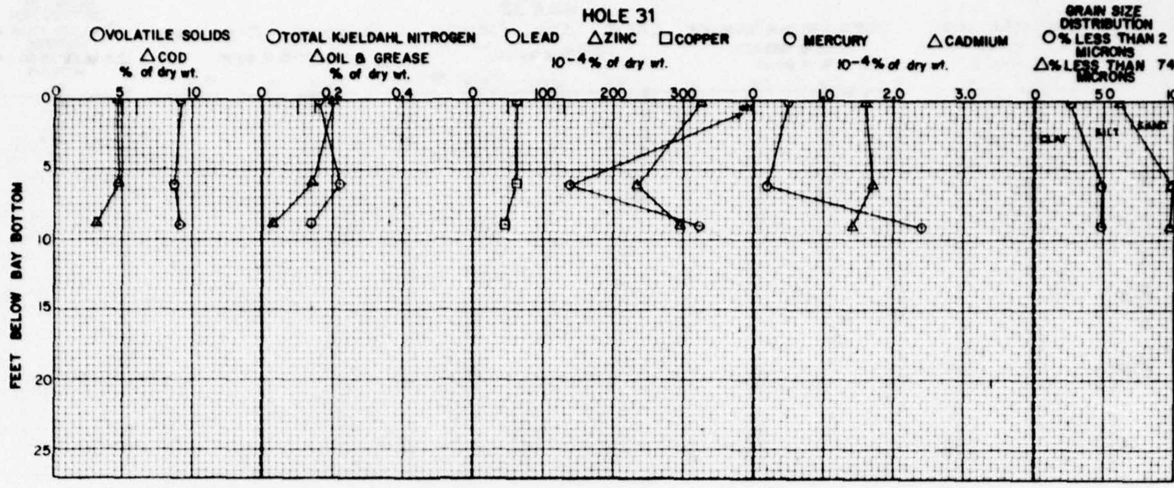

Hole No. 2D-115 (31)

Field Sample No.	PT-1	PT-2	PT-4
Laboratory Sample No.	1	2	3
Laboratory No.	PC-929	PC-930	PC-930B
Volatile Solids, % of dry wt.	9.3	8.8	9.1
C.O.D., % of dry wt.	4.7	4.7	3.2
Total Kjeldahl Nitrogen, % of dry wt.	0.16	0.22	0.14
Oil and Grease, % of dry wt.	0.20	0.14	0.03
Mercury (Hg), 10^{-4} % of dry wt.	0.5	0.2	2.4
Lead (Pb), 10^{-4} % of dry wt.	421	140	325
Zinc (Zn), 10^{-4} % of dry wt.	328	236	297
Cadmium (Cd), 10^{-4} % of dry wt.	1.6	1.7	1.4
Copper (Cu), 10^{-4} % of dry wt.	61	62	49

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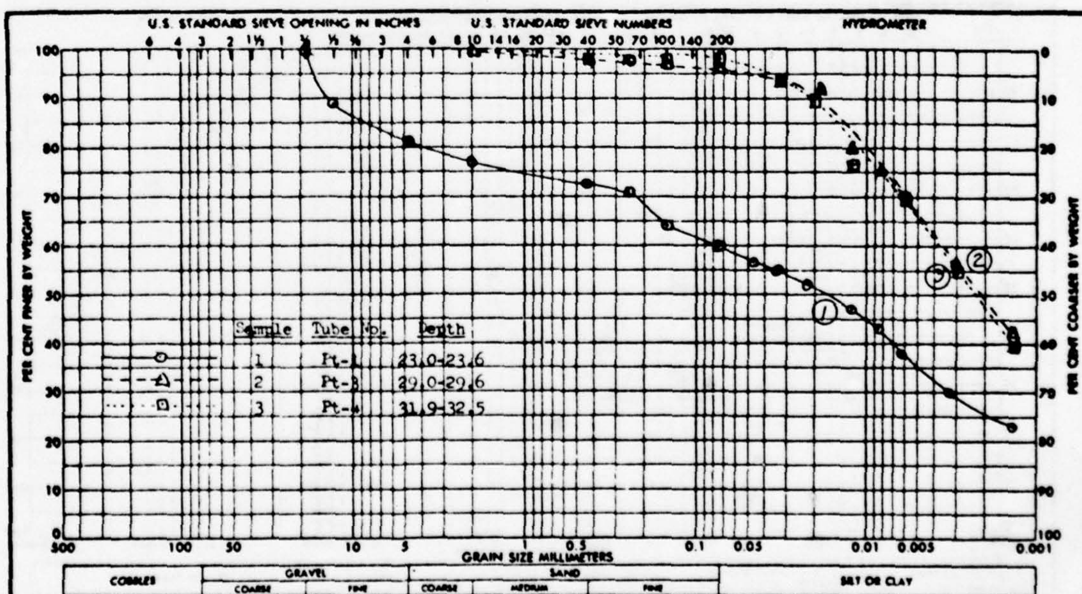

SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
Pt-1	23.0-24.7		75.5			
Pt-3	28.0-30.5		90.5			
Pt-4	30.5-33.0		83.2			

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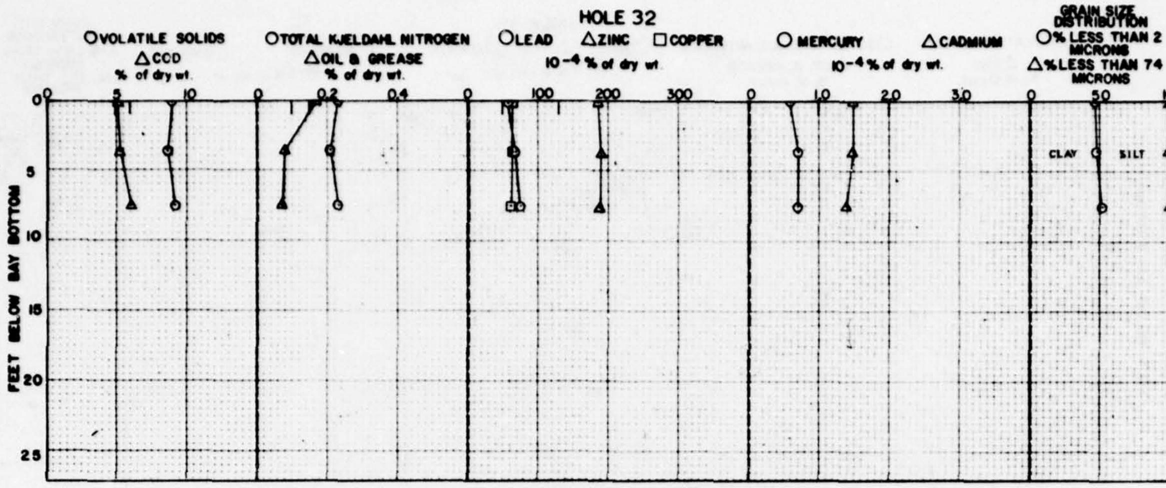

Hole No. 2D-116 (32)

Field Sample No.	PT-1	PT-2	PT-4
Laboratory Sample No.	1	2	3
Laboratory No.	PC-931	PC-932	PC-933
Volatile Solids, % of dry wt.	9.0	8.7	9.2
C.O.D., % of dry wt.	5.2	5.3	6.0
Total Kjeldahl Nitrogen, % of dry wt.	0.23	0.21	0.23
Oil and Grease, % of dry wt.	0.17	0.08	0.07
Mercury (Hg), 10^{-4} % of dry wt.	0.6	0.7	0.7
Lead (Pb), 10^{-4} % of dry wt.	59	69	66
Zinc (Zn), 10^{-4} % of dry wt.	184	190	189
Cadmium (Cd), 10^{-4} % of dry wt.	1.5	1.5	1.4
Copper (Cu), 10^{-4} % of dry wt.	61	62	60

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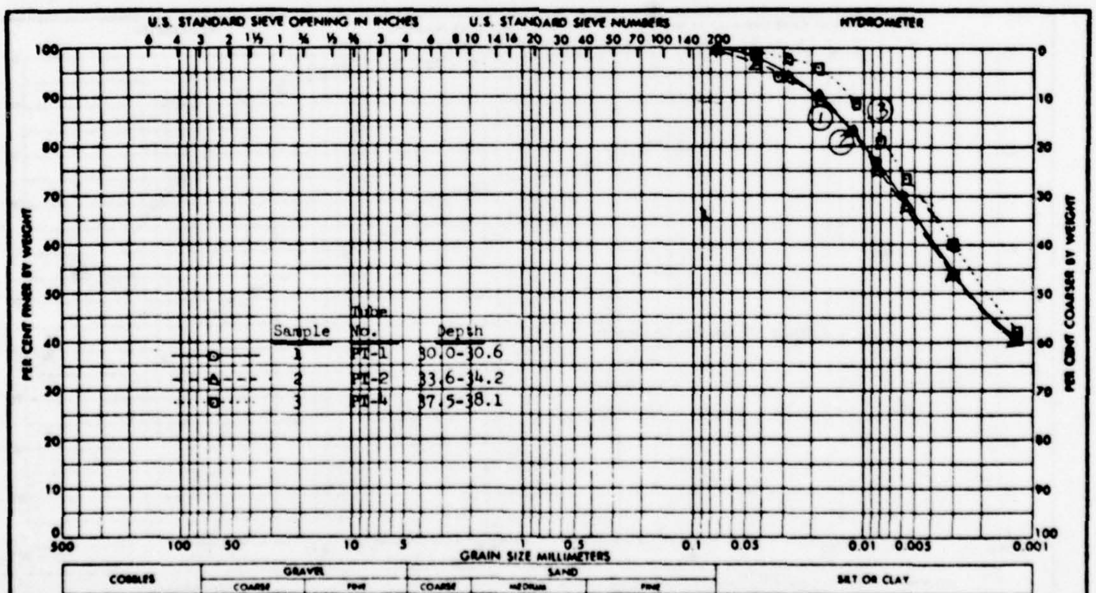

SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	30.0-32.5		120.0			
PT-2	32.5-35.0		94.0			
PT-4	37.5-40.0		96.2			

GRADATION CURVES

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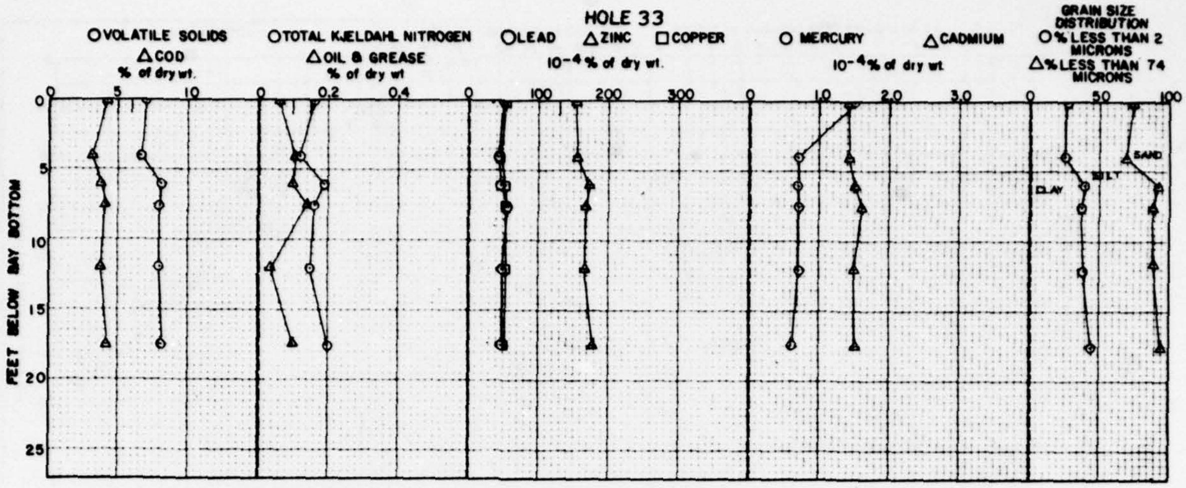
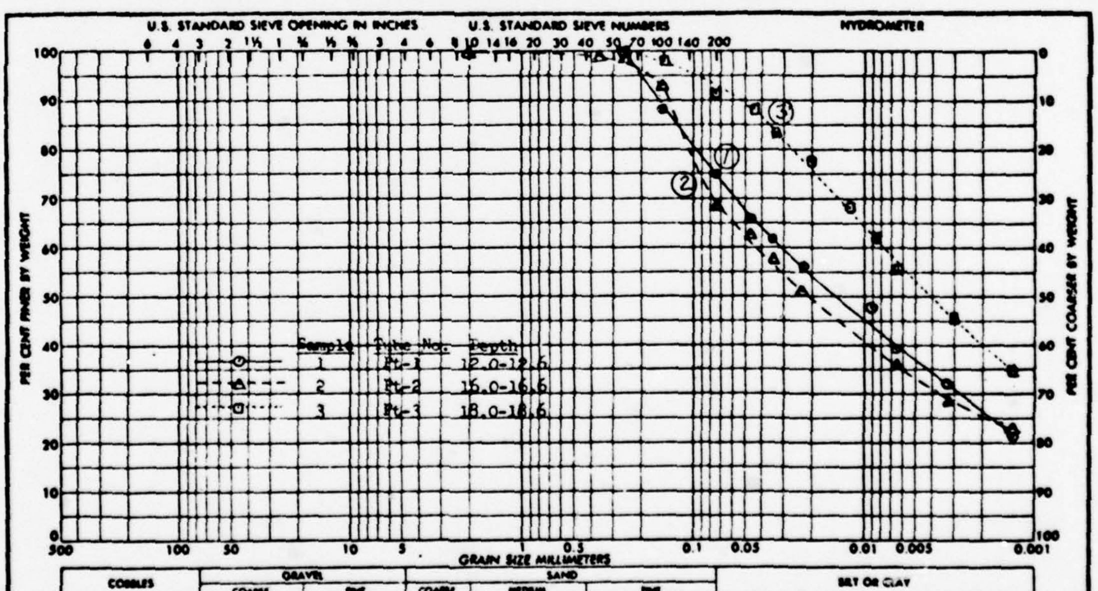


Hole No. 2D-114 (33)

Field Sample No.	PT-1	PT-2	PT-3	PT-4	PT-5	PT-8
Laboratory Sample No.	1	2	3	4	5	6
Laboratory No.	PC-923	PC-924	PC-925	PC-926	PC-927	PC-928
Volatile Solids, % of dry wt.	7.0	6.6	8.1	8.0	8.0	8.2
C.O.D., % of dry wt.	4.3	3.2	3.9	4.1	3.8	4.3
Total Kjeldahl Nitrogen, % of dry wt.	0.16	0.12	0.19	0.16	0.15	0.20
Oil and Grease, % of dry wt.	0.06	0.11	0.10	0.14	0.04	0.10
Mercury (Hg), 10^{-4} % of dry wt.	1.5	0.7	0.7	0.7	0.7	0.6
Lead (Pb), 10^{-4} % of dry wt.	50	42	45	55	47	47
Zinc (Zn), 10^{-4} % of dry wt.	151	158	171	168	165	176
Cadmium (Cd), 10^{-4} % of dry wt.	1.4	1.4	1.5	1.6	1.5	1.5
Copper (Cu), 10^{-4} % of dry wt.	51	43	54	52	53	53



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
Pt-1	12.0-14.5					
Pt-2	14.5-16.6					
Pt-3	17.0-19.5					

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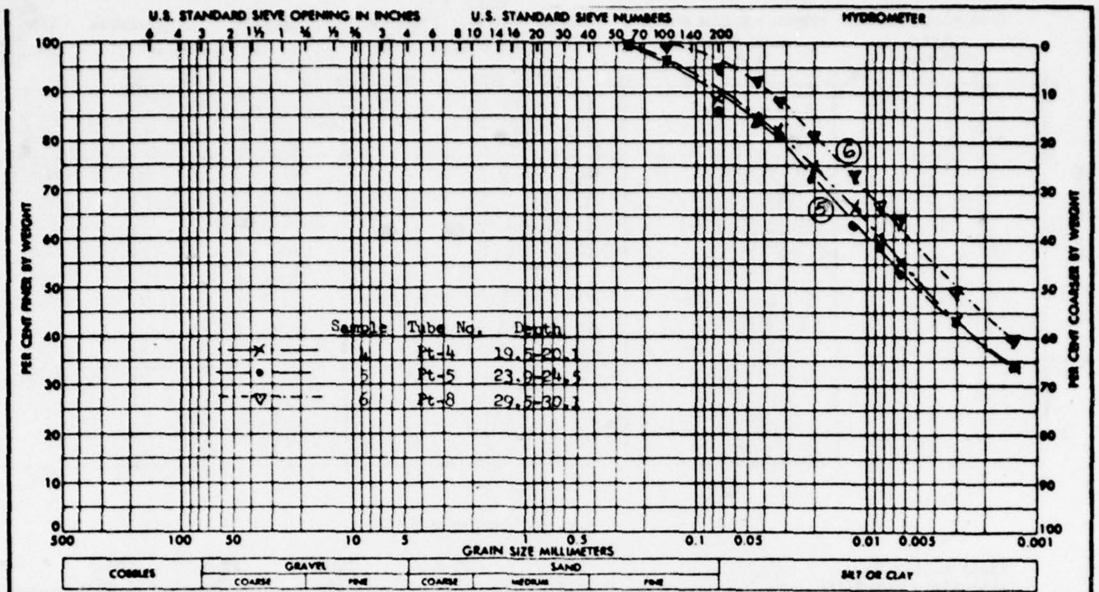

SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
Pt-4	19.5-22.0					
Pt-5	22.0-24.5					
Pt-8	29.5-32.0					

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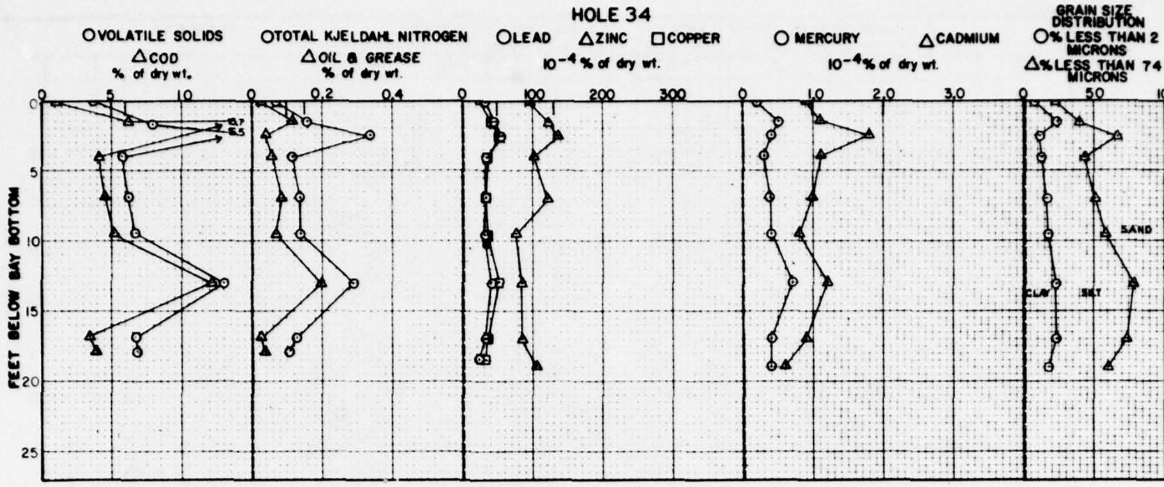
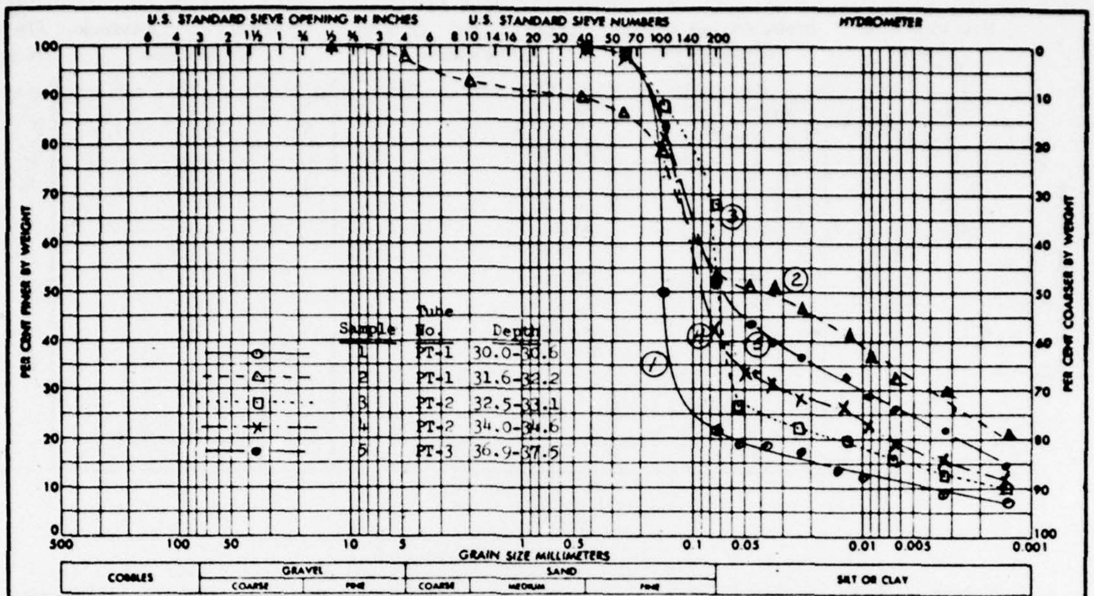


Hole No. 2D-118 (34)

Field Sample No.	PT-1	PT-1	PT-2	PT-2	PT-3
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-939	PC-940	PC-941	PC-942	PC-943
Volatile Solids, % of dry wt.	3.8	8.1	16.5	5.8	6.4
C.O.D., % of dry wt.	2.1	6.3	15.7	4.2	4.6
Total Kjeldahl Nitrogen, % of dry wt.	0.07	0.16	0.34	0.12	0.14
Oil and Grease, % of dry wt.	0.03	0.12	0.04	0.06	0.09
Mercury (Hg), 10^{-4} % of dry wt.	0.2	0.5	0.4	0.3	0.4
Lead (Pb), 10^{-4} % of dry wt.	32	49	58	35	37
Zinc (Zn), 10^{-4} % of dry wt.	99	122	136	101	121
Cadmium (Cd), 10^{-4} % of dry wt.	0.9	1.1	1.8	1.1	1.0
Copper (Cu), 10^{-4} % of dry wt.	28	43	54	36	37

Hole No. 2D-118 (34) (Cont'd)

Field Sample No.	PT-4	PT-6	PT-7	PT-8
Laboratory Sample No.	6	7	8	9
Laboratory No.	PC-944	PC-945	PC-946	PC-947
Volatile Solids, % of dry wt.	6.8	13.2	6.9	7.0
C.O.D., % of dry wt.	5.3	12.3	3.5	4.0
Total Kjeldahl Nitrogen, % of dry wt.	0.14	0.29	0.13	0.11
Oil and Grease, % of dry wt.	0.07	0.20	0.03	0.04
Mercury (Hg), 10^{-4} % of dry wt.	0.4	0.7	0.4	0.4
Lead (Pb), 10^{-4} % of dry wt.	32	41	32	26
Zinc (Zn), 10^{-4} % of dry wt.	79	88	88	107
Cadmium (Cd), 10^{-4} % of dry wt.	0.8	1.2	0.9	0.6
Copper (Cu), 10^{-4} % of dry wt.	35	51	35	33



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	30.0-32.5		46.0	& 79.0		
PT-2	32.5-35.0		60.6	& 54.5		
PT-3	35.0-37.5		59.8			

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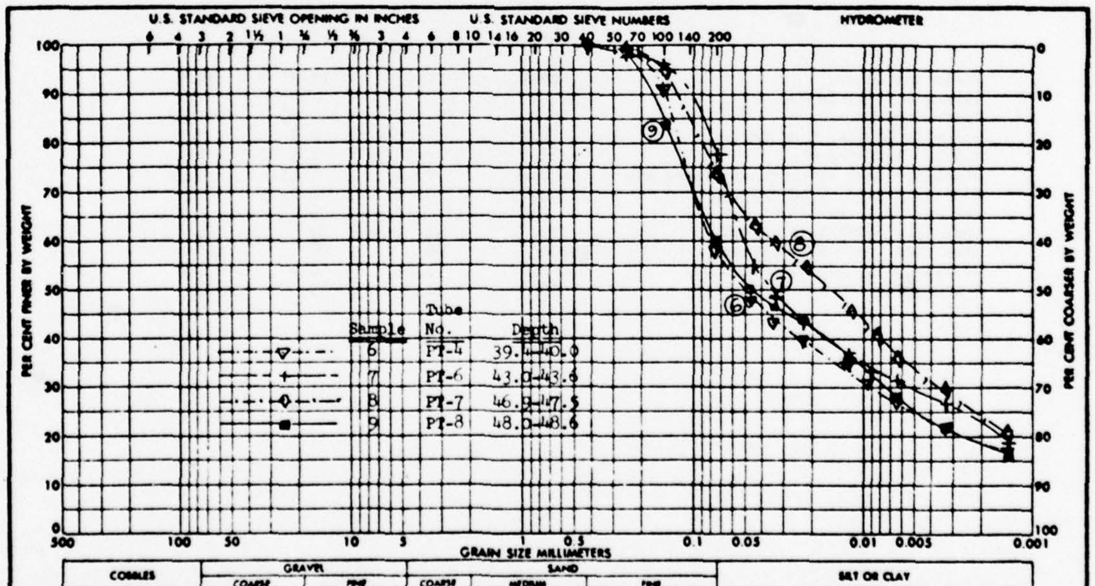

SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-4	37.5-40.0		60.7			
PT-6	42.5-45.0		98.0			
PT-7	45.0-47.5		62.0			
PT-8	47.5-50.0		57.1			

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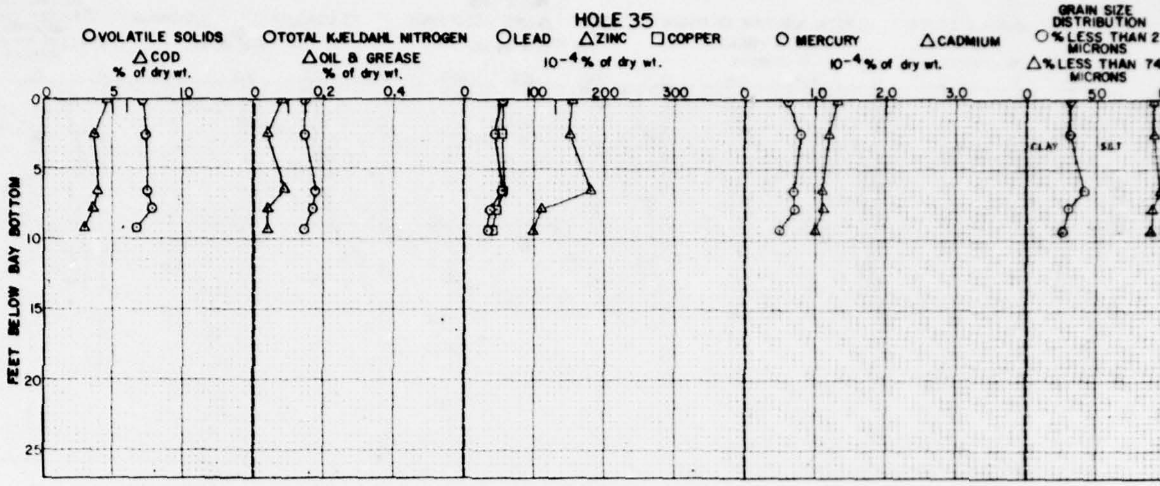

Hole No. 2D-117 (35)

Field Sample No.	PT-1	PT-2	PT-3	PT-4	PT-4
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-934	PC-935	PC-936	PC-937	PC-938
Volatile Solids, % of dry wt.	7.2	7.4	7.5	7.7	6.7
C.O.D., % of dry wt.	4.6	3.7	4.0	3.6	3.0
Total Kjeldahl Nitrogen, % of dry wt.	0.15	0.15	0.18	0.17	0.13
Oil and Grease, % of dry wt.	0.08	0.04	0.09	0.04	0.03
Mercury (Hg), 10^{-4} % of dry wt.	0.6	0.8	0.7	0.7	0.5
Lead (Pb), 10^{-4} % of dry wt.	52	46	55	38	32
Zinc (Zn), 10^{-4} % of dry wt.	154	151	181	110	100
Cadmium (Cd), 10^{-4} % of dry wt.	1.3	1.2	1.1	1.1	1.0
Copper (Cu), 10^{-4} % of dry wt.	53	57	57	48	41
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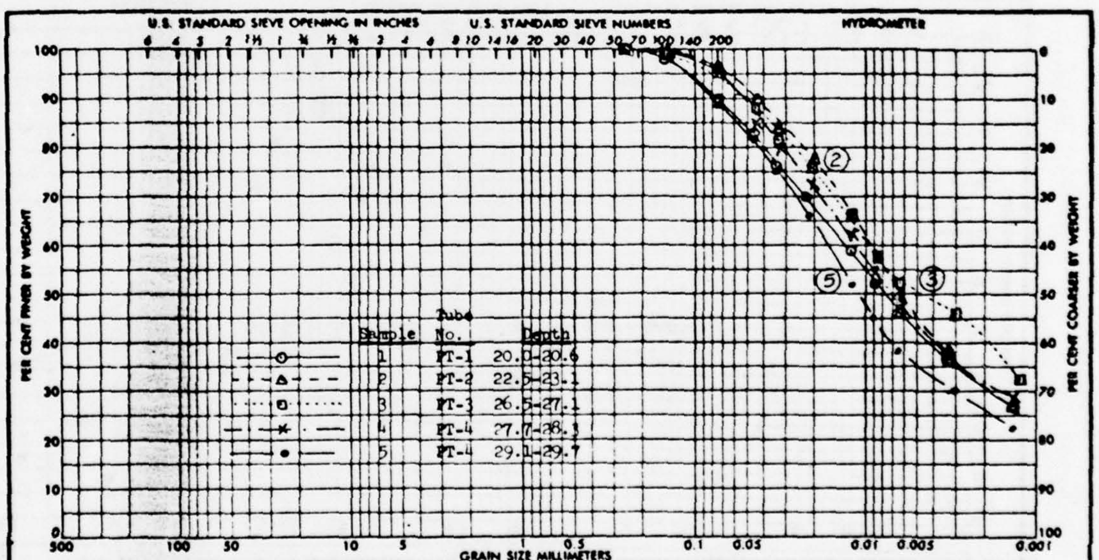

SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	20.0-22.5		73.4			
PT-2	22.5-25.0		73.4			
PT-3	25.0-27.5		92.6			
PT-4	27.5-30.0		87.6			
			76.0			

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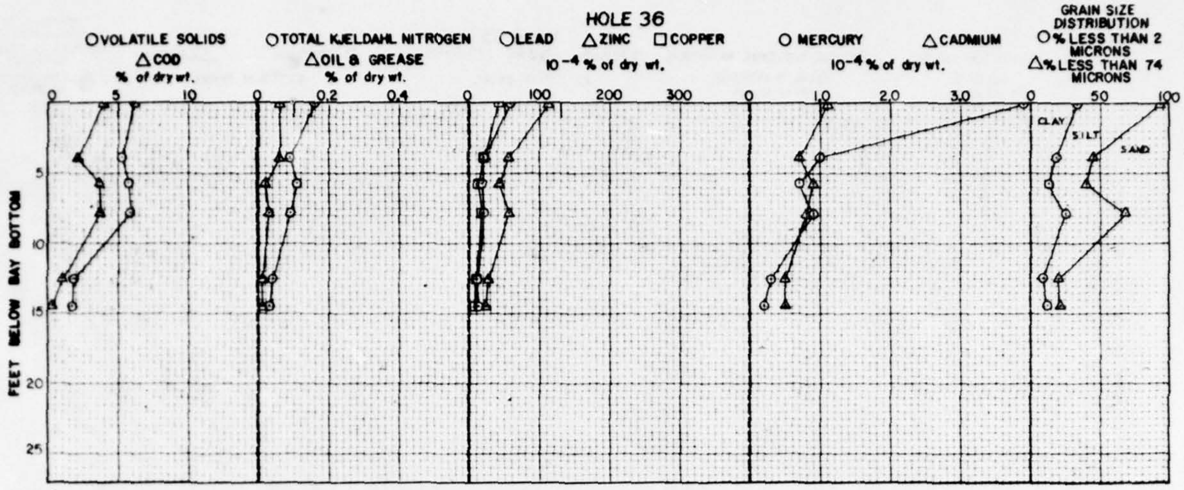
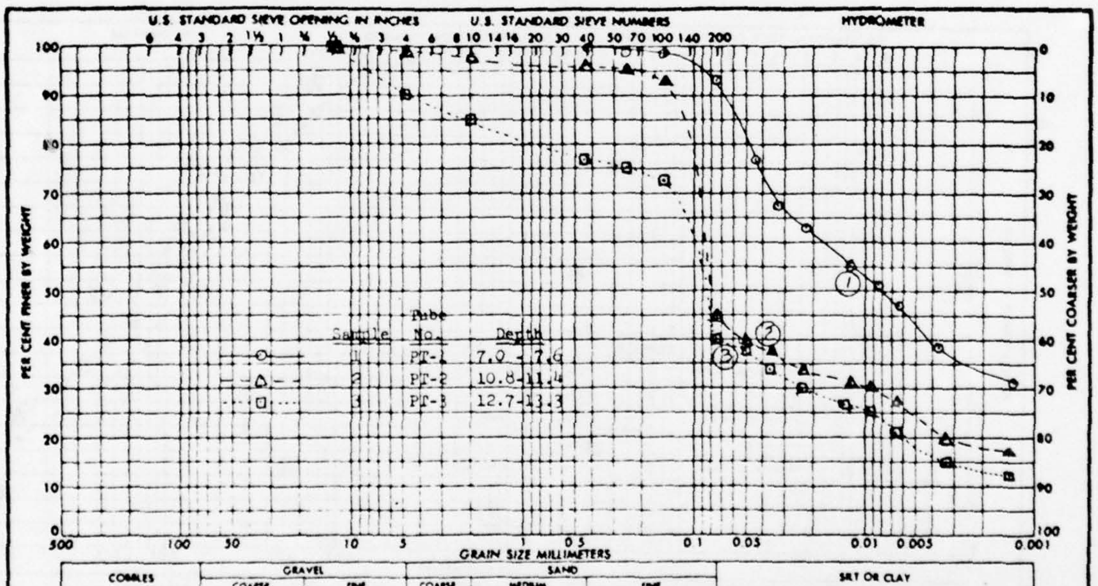


Hole No. 2D-134 (36)

Field Sample No.	PT-1	PT-2	PT-3	PT-4	PT-6	PT-6
Laboratory Sample No.	1	2	3	4	5	6
Laboratory No.	PC-1028	PC-1029	PC-1030	PC-1031	PC-1032	PC-1033
Volatile Solids, % of dry wt.	6.1	5.3	5.7	5.8	1.8	1.7
C.O.D., % of dry wt.	3.9	2.2	3.7	3.7	1.1	0.3
Total Kjeldahl Nitrogen, % of dry wt.	0.16	0.09	0.11	0.09	0.04	0.03
Oil and Grease, % of dry wt.	0.06	0.06	0.02	0.03	0.01	0.01
Mercury (Hg), 10^{-4} % of dry wt.	3.9	1.0	0.7	0.9	0.3	0.2
Lead (Pb), 10^{-4} % of dry wt.	58	21	19	20	11	13
Zinc (Zn), 10^{-4} % of dry wt.	112	57	44	57	28	23
Cadmium (Cd), 10^{-4} % of dry wt.	1.1	0.7	0.9	0.8	0.5	0.5
Copper (Cu), 10^{-4} % of dry wt.	41	21	14	18	10	8



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	7.0 - 9.5					
PT-2	9.5 -12.0					
PT-3	12.0-14.5					

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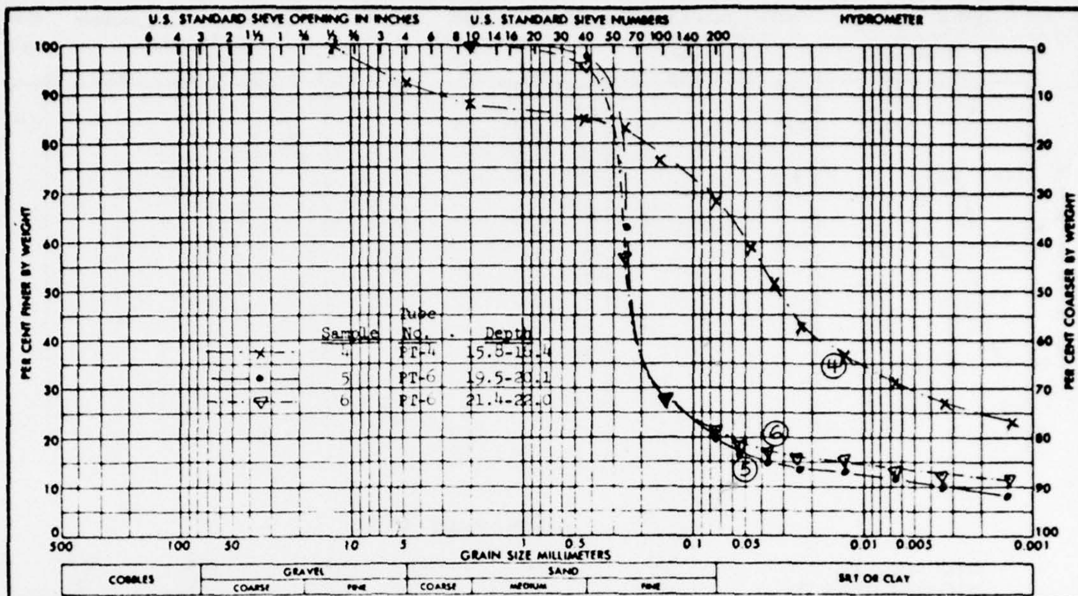

SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-4	14.5-17.0					
PT-6	19.5-22.0					

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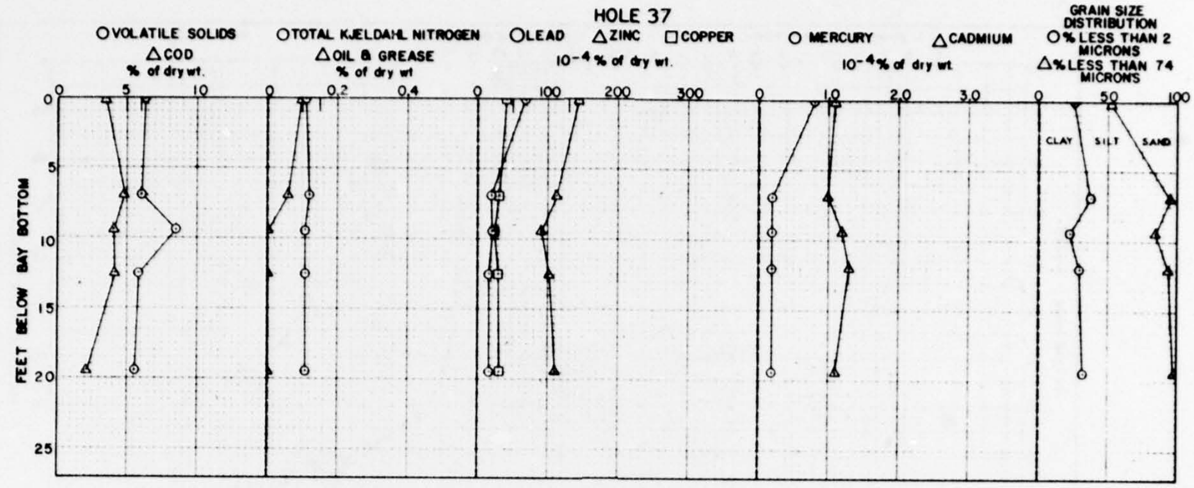
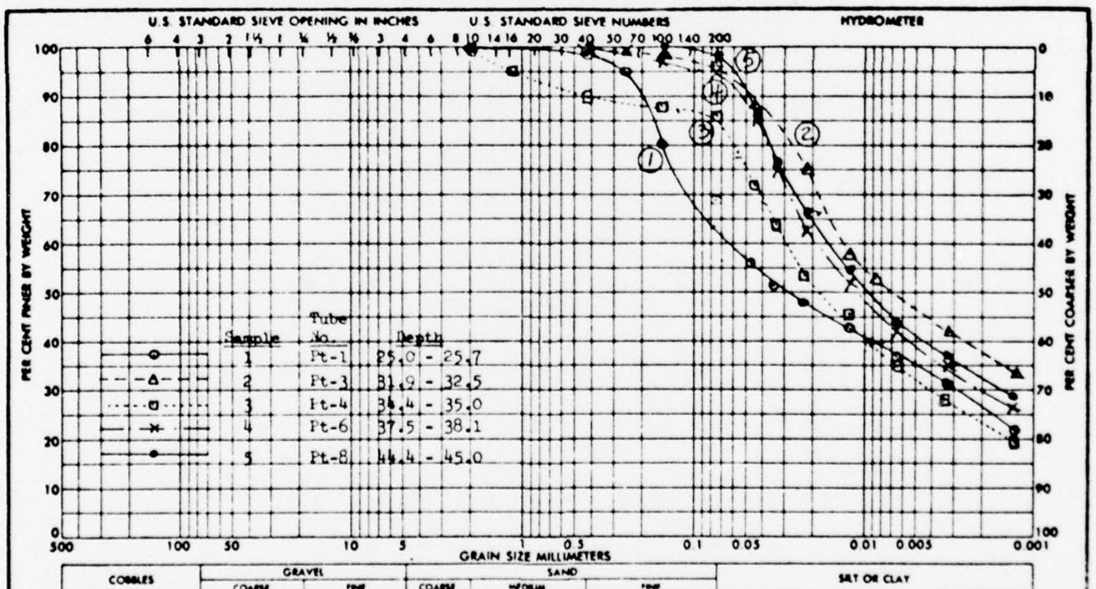


Hole No. 2D-106 (37)

Field Sample No.	PT-1	PT-3	PT-4	PT-6	PT-8
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-916	PC-917	PC-918	PC-919	PC-920
Volatile Solids, % of dry wt.	6.3	6.1	8.5	5.8	5.6
C.O.D., % of dry wt.	3.5	4.8	4.1	4.2	2.2
Total Kjeldahl Nitrogen, % of dry wt,	0.11	0.12	0.11	0.11	0.11
Oil and Grease, % of dry wt.	0.10	0.06	0.01-	0.01-	0.01-
Mercury (Hg), 10^{-4} % of dry wt.	0.8	0.2	0.2	0.2	0.2
Lead (Pb), 10^{-4} % of dry wt.	69	20	21	17	18
Zinc (Zn), 10^{-4} % of dry wt.	144	113	92	102	111
Cadmium (Cd), 10^{-4} % of dry wt.	1.1	1.0	1.2	1.3	1.1
Copper (Cu), 10^{-4} % of dry wt.	41	32	24	30	32



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
Pt-1	25.0-27.5					
Pt-3	30.0-32.5					
Pt-4	32.5-35.0					
Pt-6	37.5-40.0					
Pt-8	42.5-45.0					

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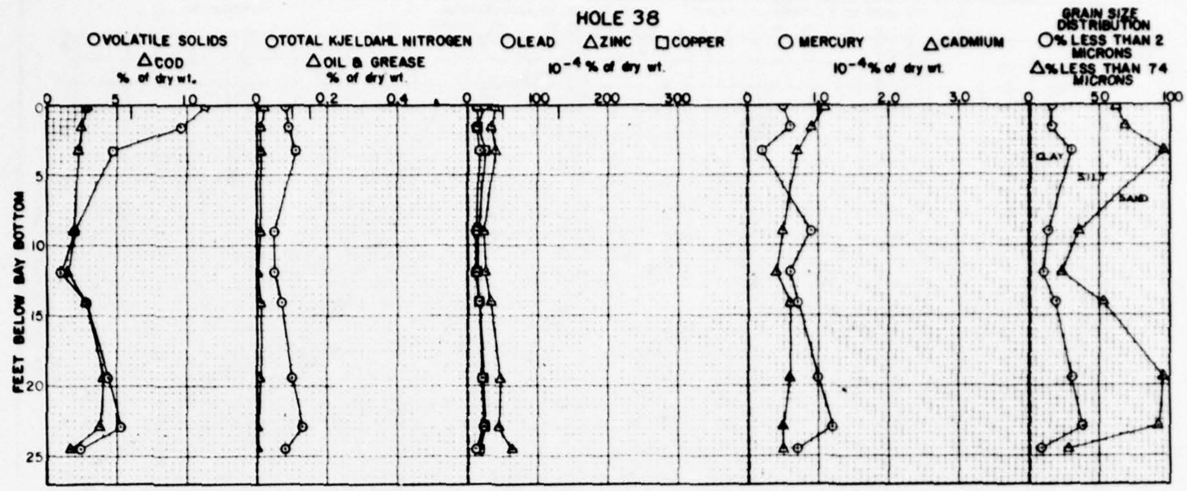
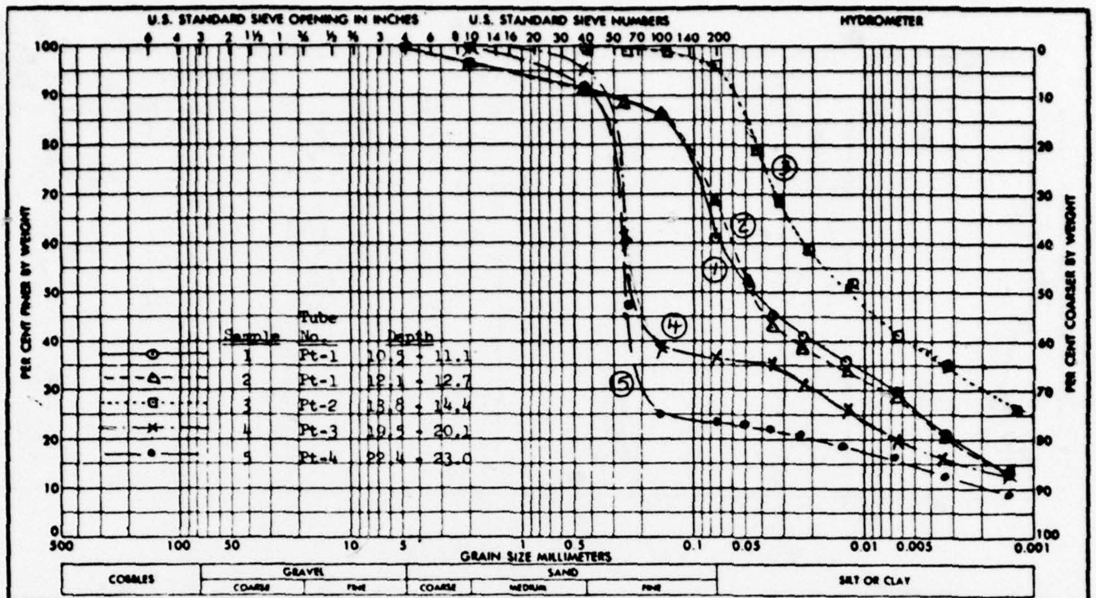


Hole No. 2D-105 (38)

Field Sample No.	PT-1	PT-1	PT-2	PT-3	PT-4
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-907	PC-908	PC-909	PC-910	PC-911
Volatile Solids, % of dry wt.	11.3	9.6	4.7	2.0	1.6
C.O.D., % of dry wt.	2.8	2.5	2.3	2.0	1.5
Total Kjeldahl Nitrogen, % of dry wt.	0.08	0.09	0.11	0.05	0.05
Oil and Grease, % of dry wt.	0.02	0.01	0.01	0.01	0.01-
Mercury (Hg), 10^{-4} % of dry wt.	0.5	0.6	0.2	0.9	0.6
Lead (Pb), 10^{-4} % of dry wt.	25	14	18	12	12
Zinc (Zn), 10^{-4} % of dry wt.	40	34	40	23	27
Cadmium (Cd), 10^{-4} % of dry wt.	1.1	0.9	0.7	[illegible]5	0.4
Copper (Cu), 10^{-4} % of dry wt.	14	15	25	1[illegible]	13

Hole No. 2D-105 (38) (Cont'd)

Field Sample No.	PT-5	PT-7	PT-9	PT-9
Laboratory Sample No.	6	7	8	9
Laboratory No.	PC-912	PC-913	PC-914	PC-915
Volatile Solids, % of dry wt.	2.8	4.4	5.3	2.4
C.O.D., % of dry wt.	2.8	4.1	3.8	1.7
Total Kjeldahl Nitrogen, % of dry wt.	0.07	0.10	0.13	0.08
Oil and Grease, % of dry wt.	0.01	0.01	0.01-	0.01-
Mercury (Hg), 10^{-4} % of dry wt.	0.7	1.0	1.2	0.7
Lead (Pb), 10^{-4} % of dry wt.	17	21	23	12
Zinc (Zn), 10^{-4} % of dry wt.	33	48	46	63
Cadmium (Cd), 10^{-4} % of dry wt.	0.6	0.6	0.5	0.5
Copper (Cu), 10^{-4} % of dry wt.	17	23	23	18



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
Pt-1	10.5-13.0					
Pt-2	13.0-15.5					
Pt-3	18.0-20.5					
Pt-4	20.5-23.0					

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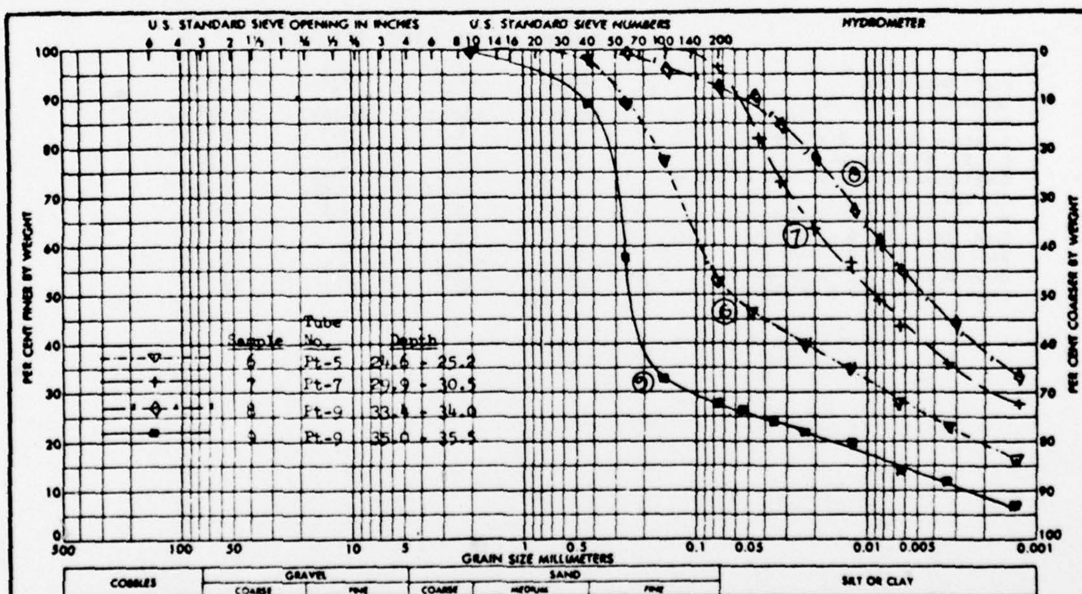

SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
Pt-5	23.0-25.5					
Pt-6	25.5-28.0					
Pt-7	28.0-30.5					
Pt-8	30.5-33.0					
Pt-9	33.0-35.5					

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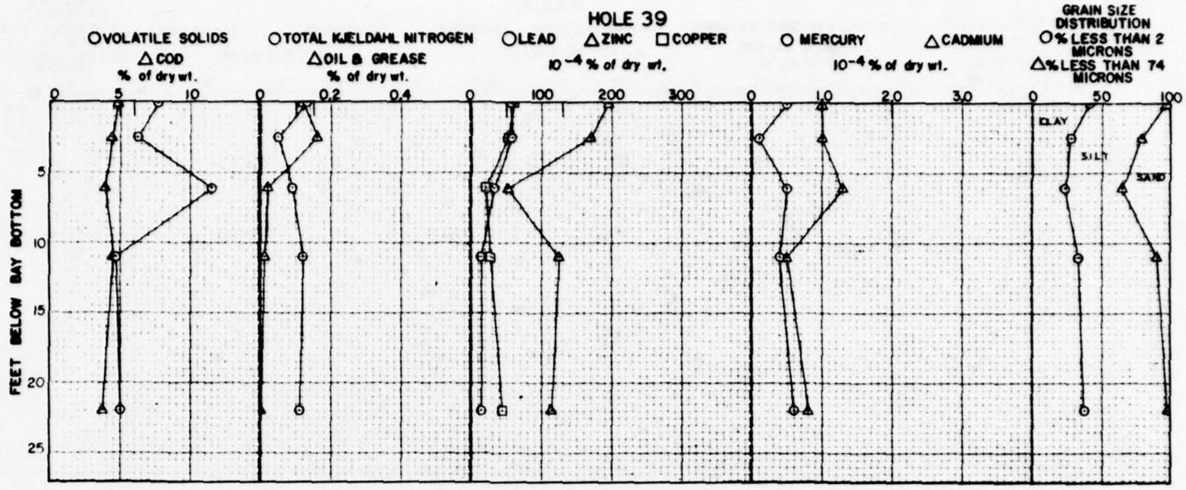
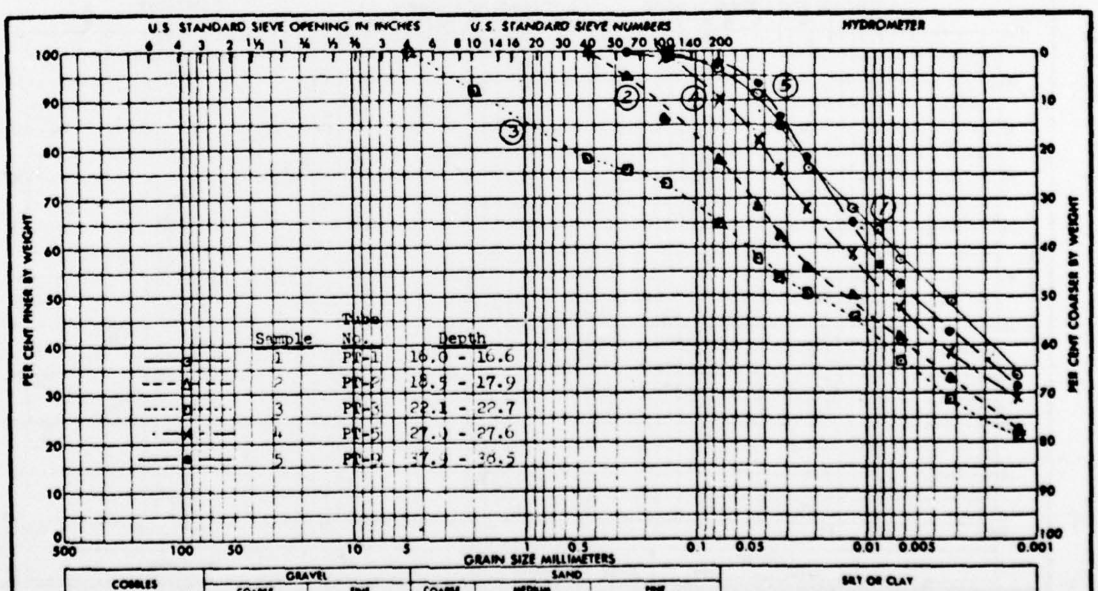


Hole No. 2D-100 (39)

Field Sample No.	PT-1	PT-2	PT-3	PT-5	PT-9
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-887	PC-888	PC-889	PC-890	PC-891
Volatile Solids, % of dry wt.	7.7	6.3	11.5	4.7	5.0
C.O.D., % of dry wt.	4.9	4.4	3.9	4.5	3.7
Total Kjeldahl Nitrogen, % of dry wt.	0.13	0.05	0.09	0.12	0.11
Oil and Grease, % of dry wt.	0.12	0.16	0.02	0.01	0.01-
Mercury (Hg), 10^{-4} % of dry wt.	0.5	0.1	0.5	0.4	0.6
Lead (Pb), 10^{-4} % of dry wt.	57	58	33	14	14
Zinc (Zn), 10^{-4} % of dry wt.	196	170	52	125	114
Cadmium (Cd), 10^{-4} % of dry wt.	1.0	1.0	1.3	0.5	0.8
Copper (Cu), 10^{-4} % of dry wt.	60	53	21	28	44



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	16.0 - 17.7					
PT-2	18.5 - 20.2					
PT-3	21.0 - 23.5					
PT-5	26.0 - 28.5					
PT-9	36.0 - 38.5					

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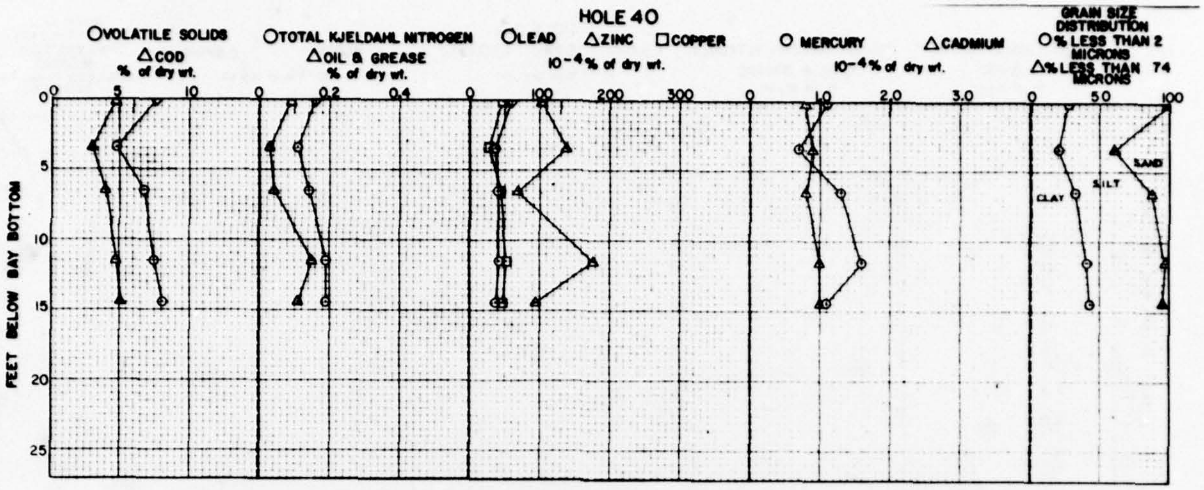
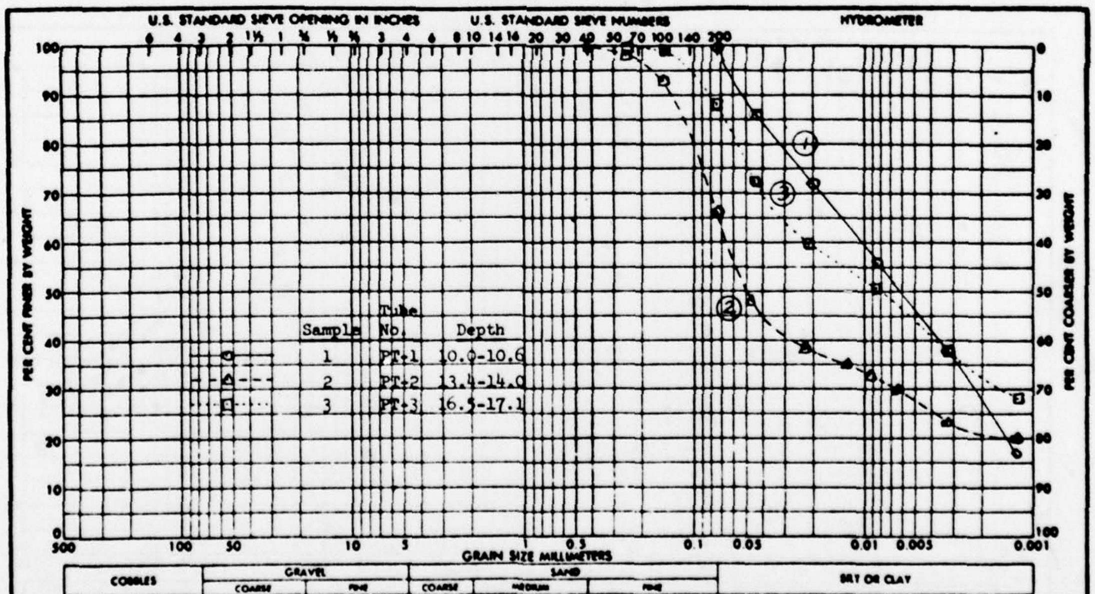


Hole No. 2D-103 (40)

Field Sample No.	PT-1	PT-2	PT-3	PT-5	PT-6
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-900	PC-901	PC-902	PC-903	PC-904
Volatile Solids, % of dry wt.	7.6	4.8	6.7	7.5	8.1
C.O.D., % of dry wt.	4.7	3.1	4.0	4.8	5.1
Total Kjeldahl Nitrogen, % of dry wt.	0.16	0.11	0.14	0.19	0.19
Oil and Grease, % of dry wt.	0.09	0.03	0.04	0.15	0.11
Mercury (Hg), 10^{-4} % of dry wt.	1.1	0.7	1.3	1.6	1.1
Lead (Pb), 10^{-4} % of dry wt.	60	36	40	42	38
Zinc (Zn), 10^{-4} % of dry wt.	102	139	69	177	94
Cadmium (Cd), 10^{-4} % of dry wt.	0.8	0.9	0.8	1.0	1.0
Copper (Cu), 10^{-4} % of dry wt.	47	29	44	52	48



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	10.0-12.5					
PT-2	12.5-15.0					
PT-3	15.0-17.5					

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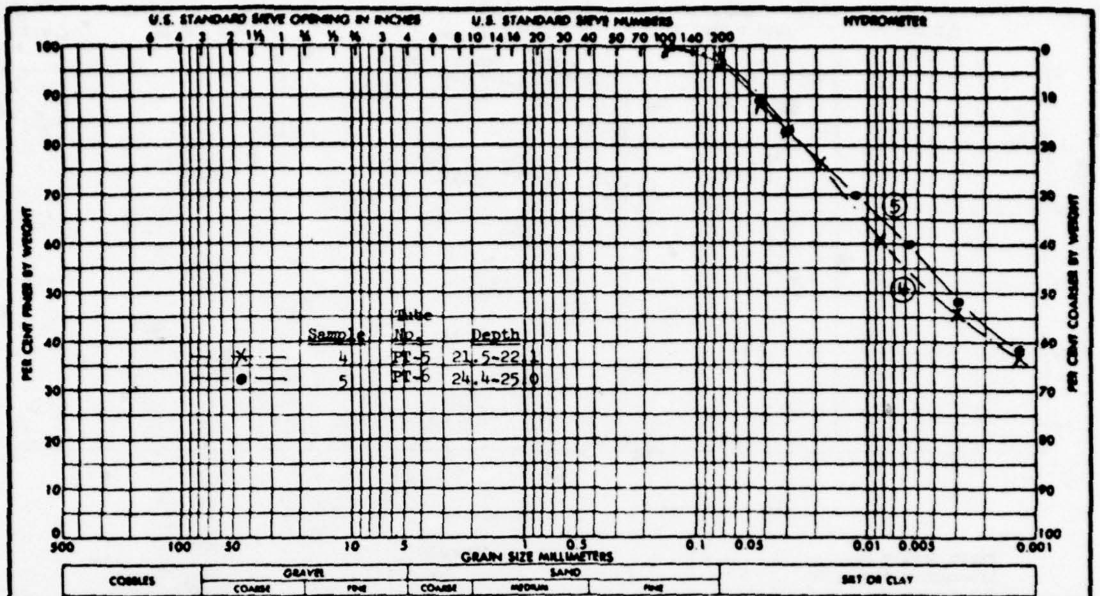

SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-5	20.0-22.5					
PT-6	22.5-25.0					

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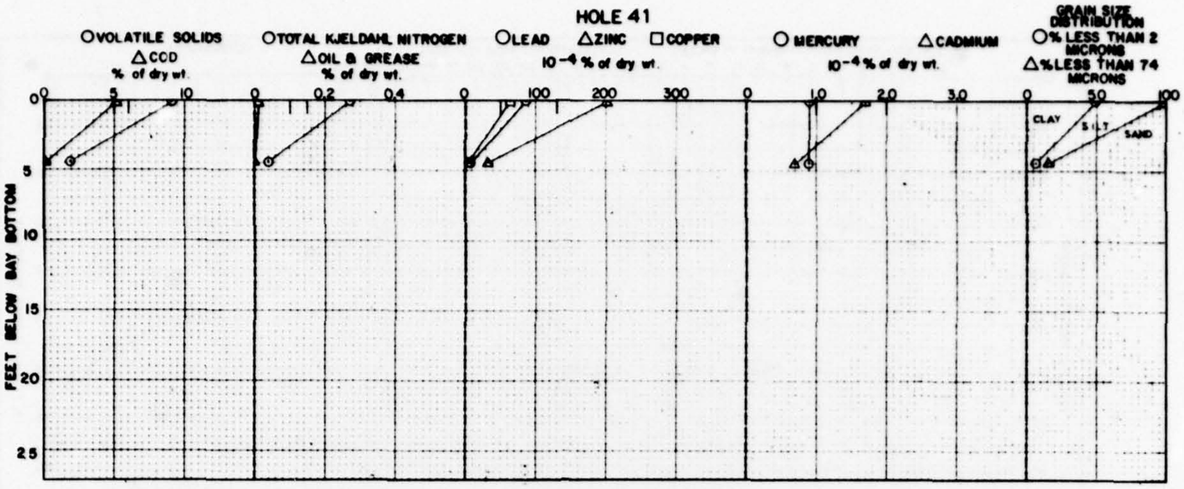
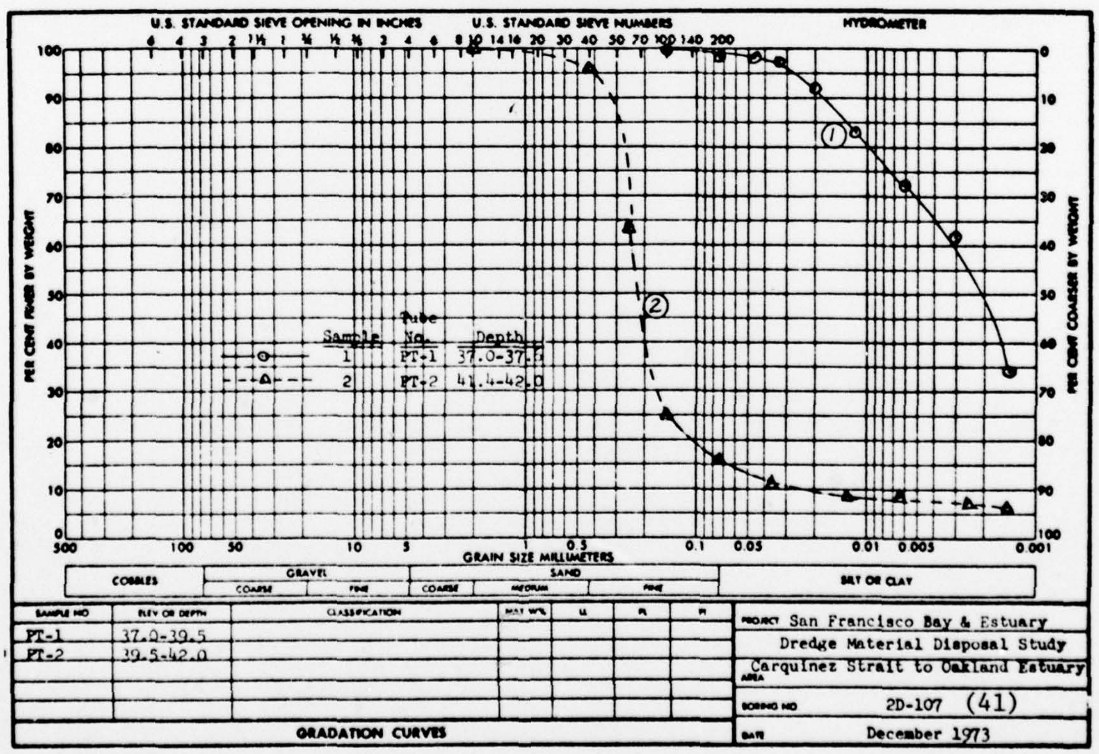
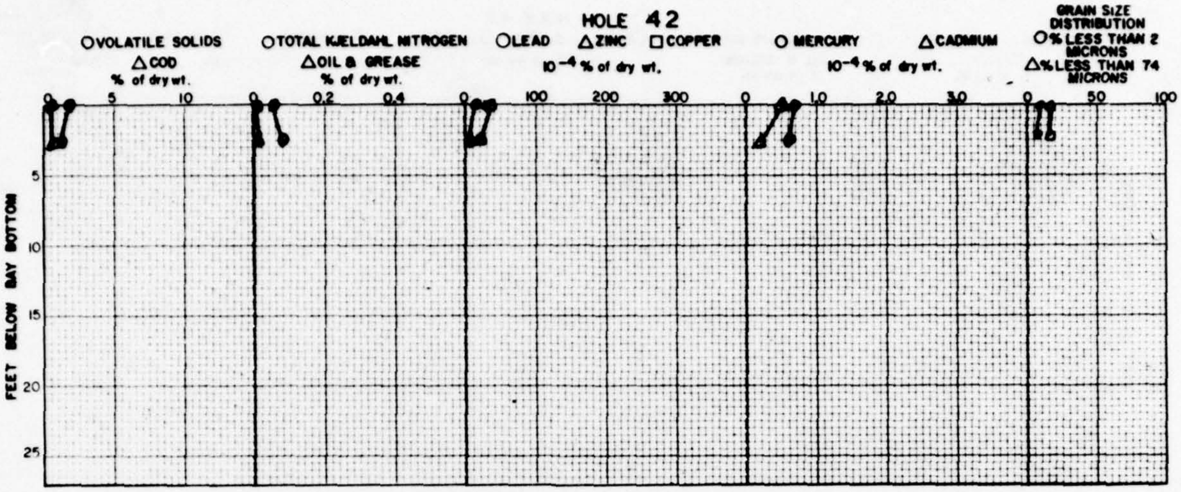


Hole No. 2D-107 (41)

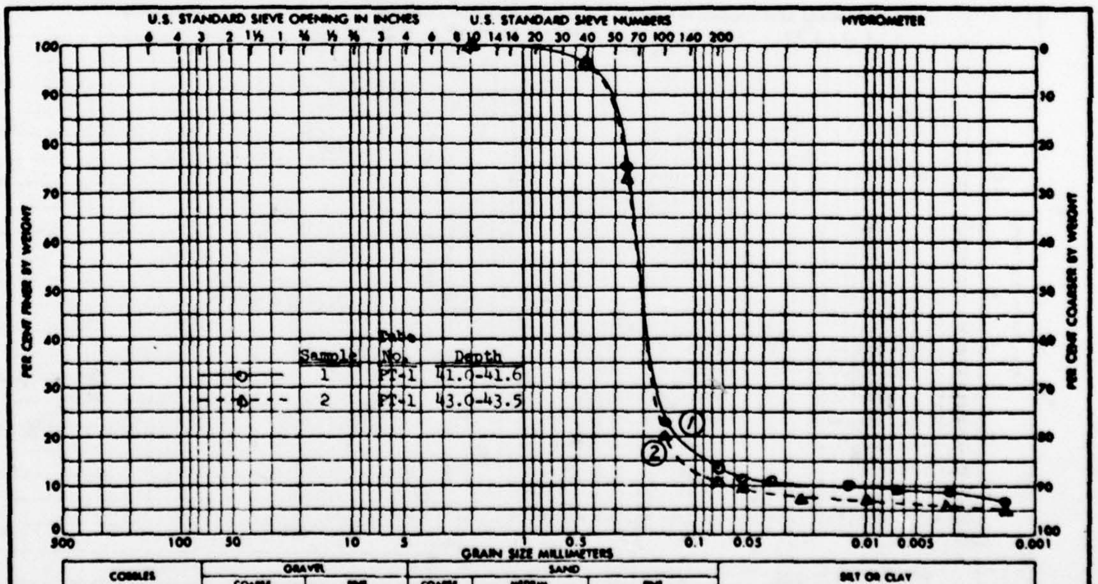
Field Sample No.	PT-1	PT-2
Laboratory Sample No.	1	2
Laboratory No.	PC-921	PC-922
Volatile Solids, % of dry wt.	9.1	1.9
C.O.D., % of dry wt.	5.2	0.2
Total Kjeldahl Nitrogen, % of dry wt.	0.27	0.04
Oil and Grease, % of dry wt.	0.01	0.01-
Mercury (Hg), 10^{-4} % of dry wt.	0.9	0.9
Lead (Pb), 10^{-4} % of dry wt.	87	9
Zinc (Zn), 10^{-4} % of dry wt.	201	34
Cadmium (Cd), 10^{-4} % of dry wt.	1.7	0.7
Copper (Cu), 10^{-4} % of dry wt.	64	6





Hole No. 2D-104 (42)

Field Sample No.	Pt-1	Pt-1
Laboratory Sample No.	1	2
Laboratory No.	PC-905	PC-906
Volatile Solids, % of dry wt.	1.8	1.2
C.O.D., % of dry wt.	0.6	0.6
Total Kjeldahl Nitrogen, % of dry wt.	0.05	0.08
Oil and Grease, % of dry wt.	0.01	0.01
Mercury (Hg), 10^{-4} % of dry wt.	0.7	0.6
Lead (Pb), 10^{-4} % of dry wt.	15	7
Zinc (Zn), 10^{-4} % of dry wt.	35	20
Cadmium (Cd), 10^{-4} % of dry wt.	0.5	0.2
Copper (Cu), 10^{-4} % of dry wt.	14	8



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	41.0-43.5					

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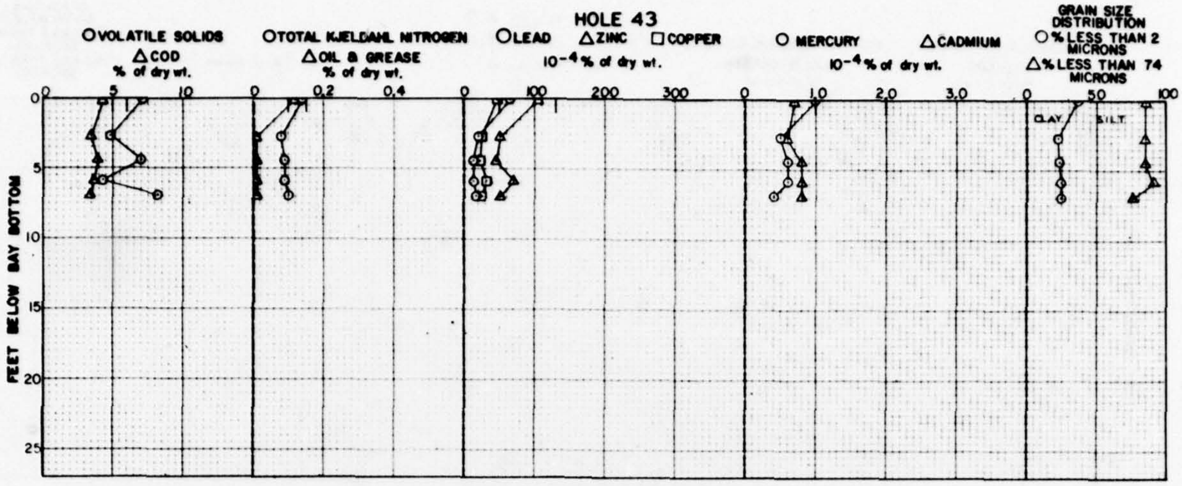
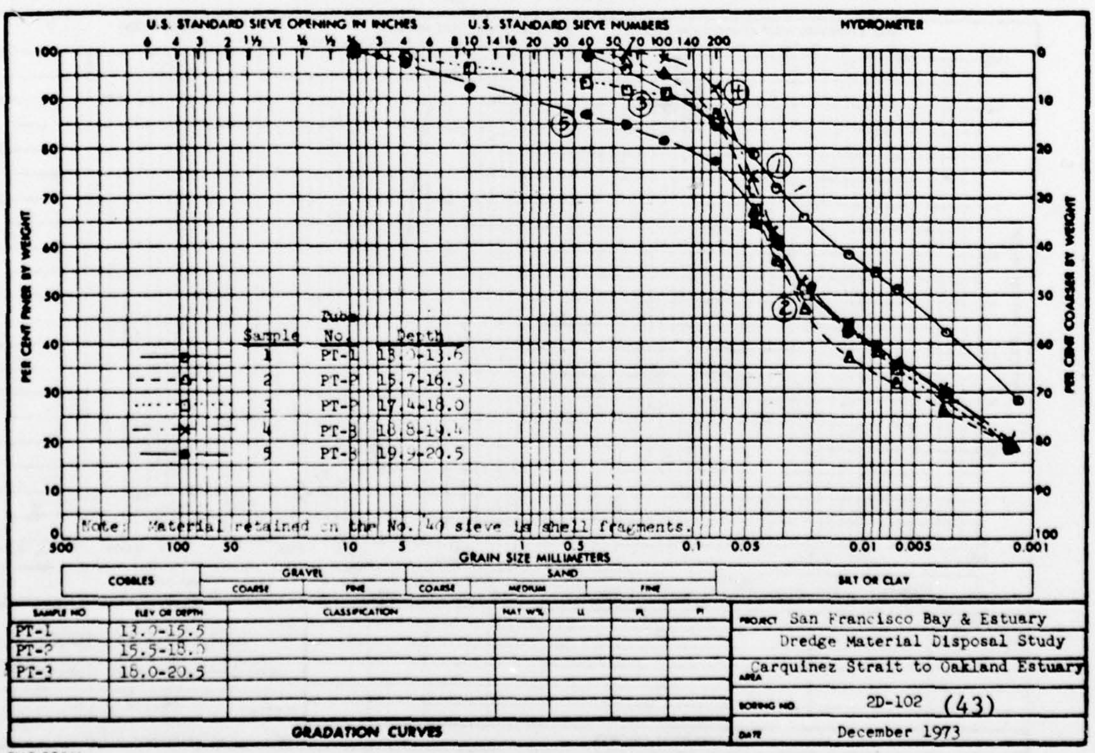
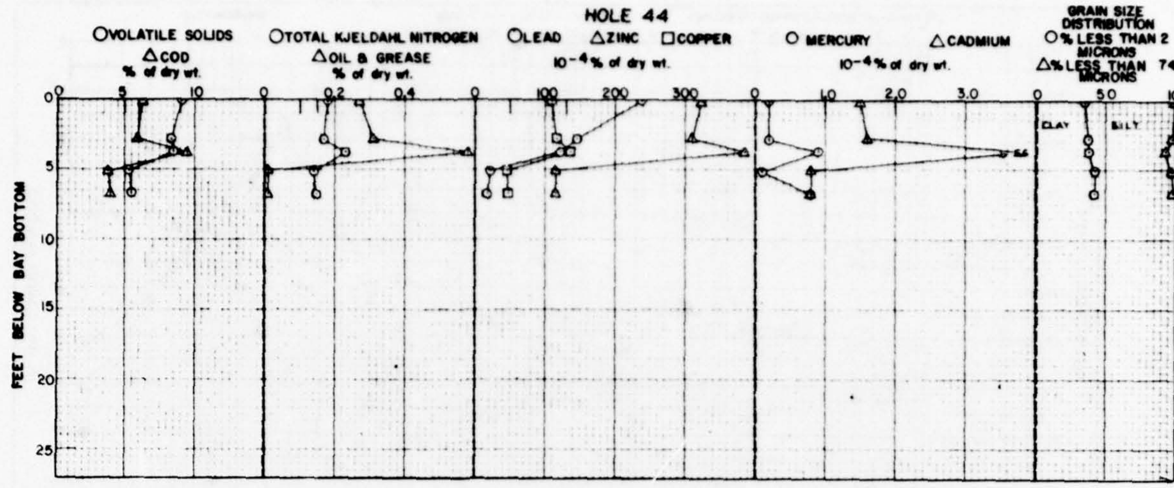


Hole No. 2D-102 (43)

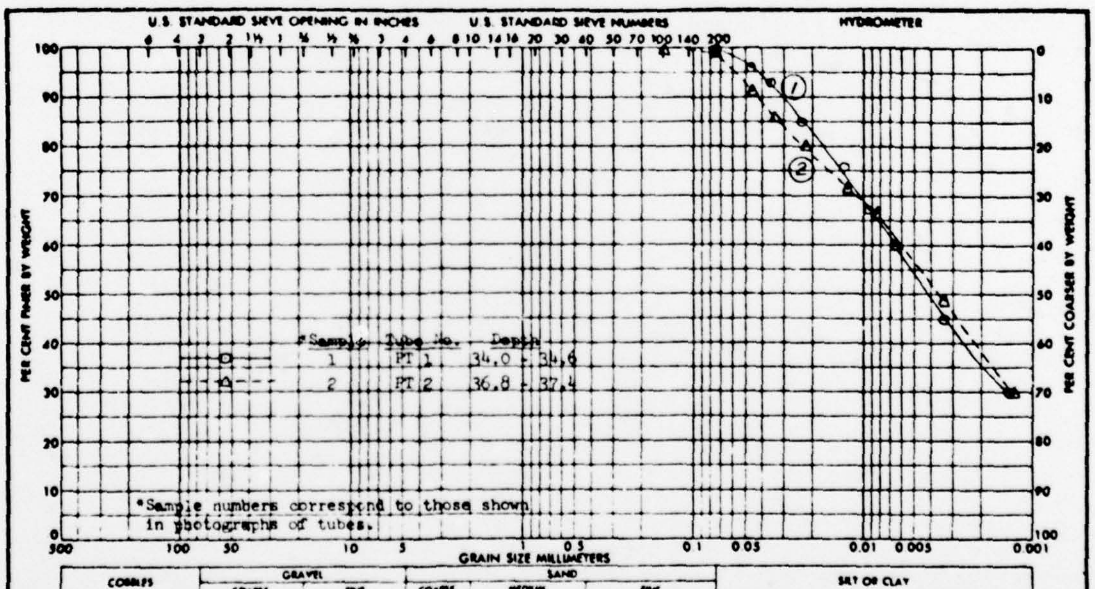
Field Sample No.	PT-1	PT-2	PT-2	PT-3	PT-3
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-895	PC-896	PC-897	PC-898	PC-899
Volatile Solids, % of dry wt.	7.1	4.8	7.0	4.3	8.2
C.O.D., % of dry wt.	4.3	3.5	3.9	3.7	3.4
Total Kjeldahl Nitrogen, % of dry wt.	0.14	0.08	0.09	0.09	0.10
Oil and Grease, % of dry wt.	0.12	0.01	0.01	0.01	0.01
Mercury (Hg), 10^{-4} % of dry wt.	1.0	0.5	0.6	0.6	0.4
Lead (Pb), 10^{-4} % of dry wt.	65	20	13	14	16
Zinc (Zn), 10^{-4} % of dry wt.	105	51	45	70	51
Cadmium (Cd), 10^{-4} % of dry wt.	0.7	0.6	0.8	0.8	0.8
Copper (Cu), 10^{-4} % of dry wt.	47	25	23	31	25





Hole No. 2D-95 (44)

Field Sample No.	PT-1	PT-2	PT-2	PT-3	PT-3
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-873	PC-874	PC-875	PC-876	PC-877
Volatile Solids, % of dry wt.	9.1	8.3	8.5	5.3	5.5
C.O.D., % of dry wt.	6.3	5.9	9.0	3.8	4.0
Total Kjeldahl Nitrogen, % of dry wt.	0.18	0.17	0.23	0.14	0.15
Oil and Grease, % of dry wt.	0.27	0.31	0.58	0.01	0.01
Mercury (Hg), 10^{-4} % of dry wt.	0.2	0.2	0.9	0.1	0.8
Lead (Pb), 10^{-4} % of dry wt.	237	146	123	23	18
Zinc (Zn), 10^{-4} % of dry wt.	323	310	386	115	115
Cadmium (Cd), 10^{-4} % of dry wt.	1.5	1.6	6.6	0.8	0.8
Copper (Cu), 10^{-4} % of dry wt.	110	117	136	46	48



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	34.0-36.5					
PT-2	36.5-39.0					

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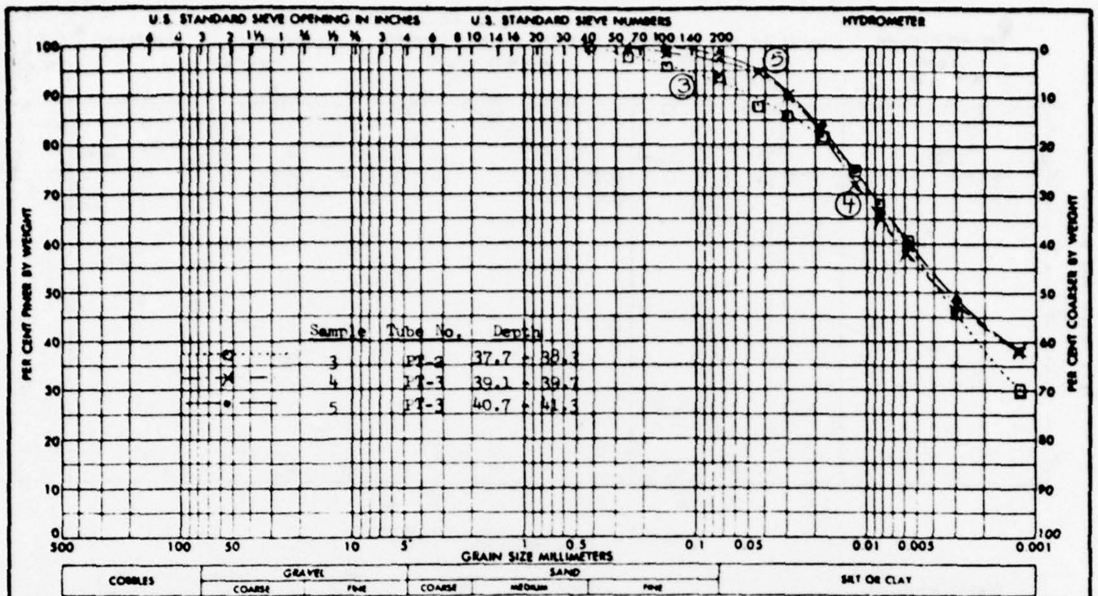

SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-2	36.5-39.0					
PT-3	39.0-41.5					

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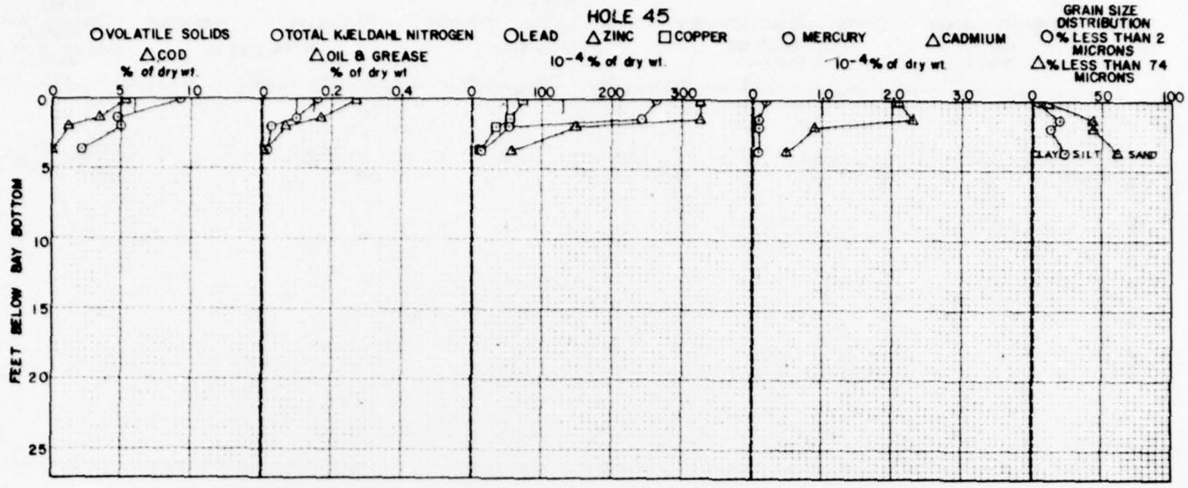
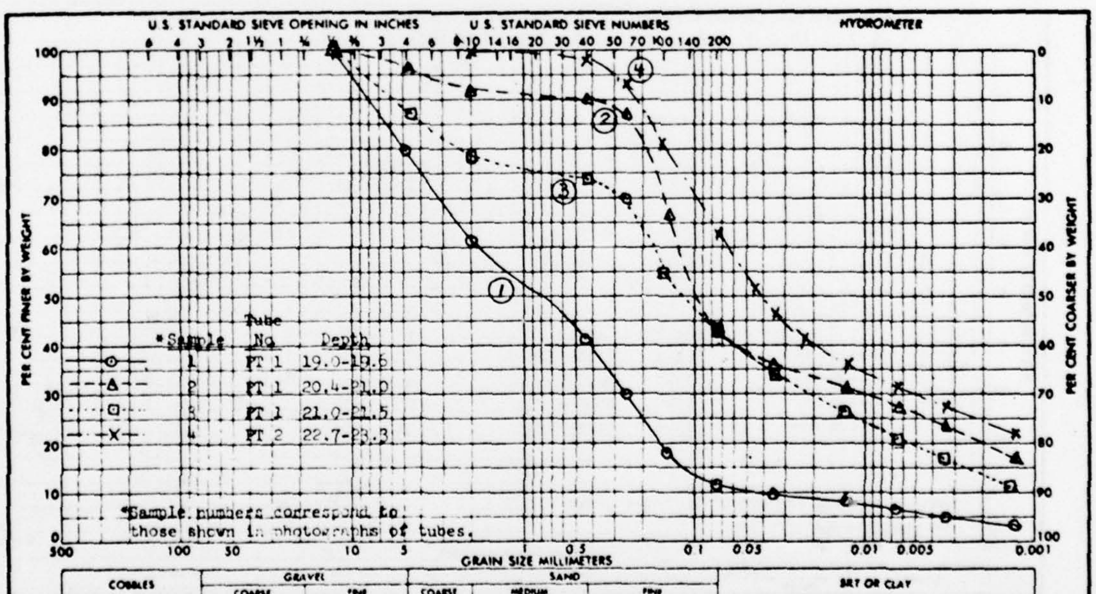


Hole No. 2D-94 (45)

Field Sample No.	PT-1	PT-1	PT-1	PT-2
Laboratory Sample No.	1	2	3	4
Laboratory No.	PC-869	PC-870	PC-871	PC-872
Volatile Solids, % of dry wt.	9.3	4.8	5.0	2.3
C.O.D., % of dry wt.	5.3	3.5	1.3	0.1
Total Kjeldahl Nitrogen, % of dry wt.	0.16	0.10	0.03	0.02
Oil and Grease, % of dry wt.	0.27	0.17	0.07	0.01
Mercury (Hg), 10^{-4} % of dry wt.	0.2	0.1	0.1	0.1
Lead (Pb), 10^{-4} % of dry wt.	264	244	53	15
Zinc (Zn), 10^{-4} % of dry wt.	327	328	150	59
Cadmium (Cd), 10^{-4} % of dry wt.	2.1	2.3	0.9	0.5
Copper (Cu), 10^{-4} % of dry wt.	73	55	35	14



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	19.0-21.5					
PT-2	21.5-24.0					

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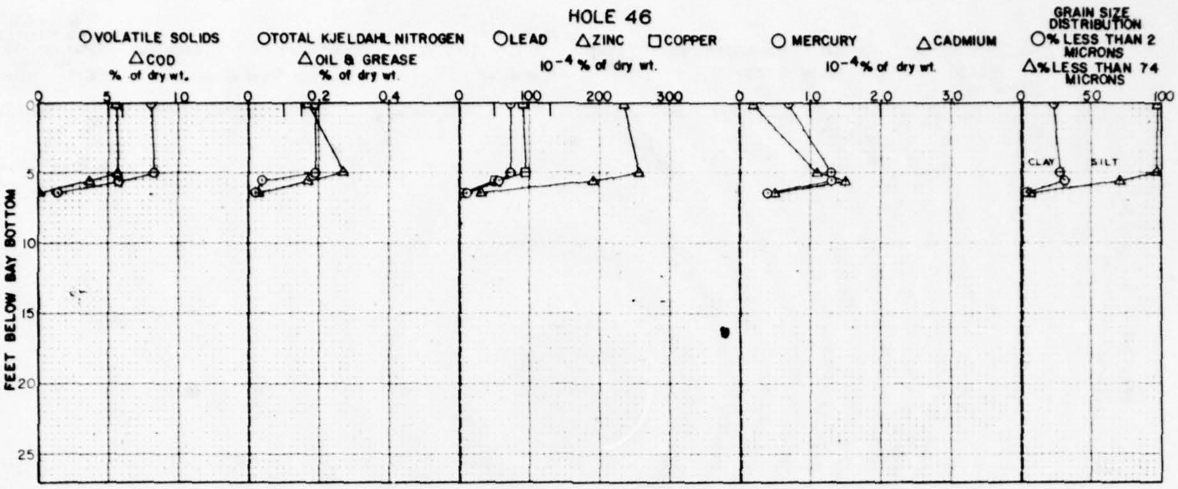
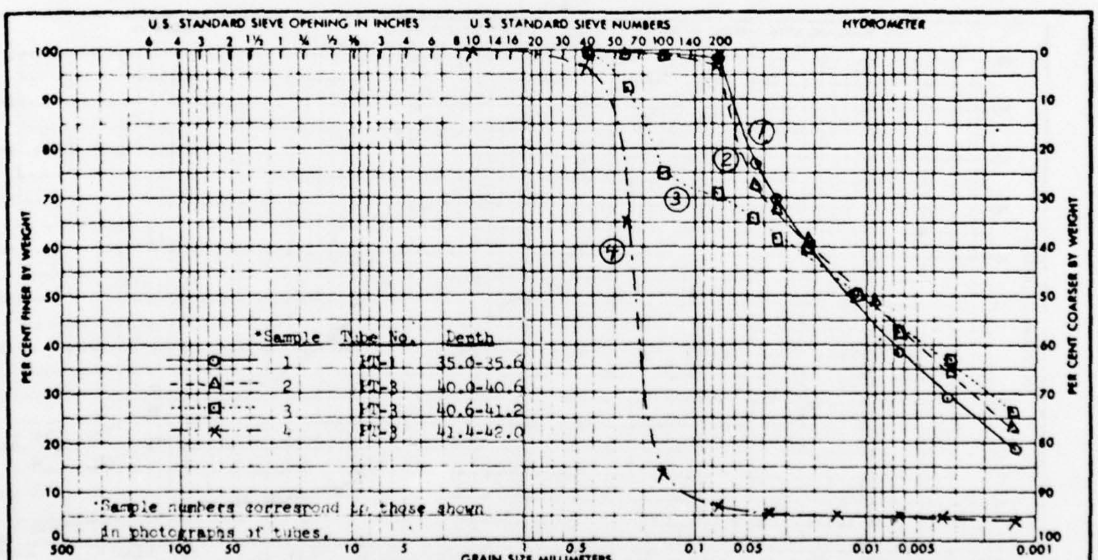


Hole No. 2D-99 (46)

Field Sample No.	PT-1	PT-2	PT-3	PT-3
Laboratory Sample No.	1	2	3	4
Laboratory No.	PC-883	PC-884	PC-885	PC-886
Volatile Solids, % of dry wt.	8.1	8.3	5.8	1.4
C.O.D., % of dry wt.	5.6	5.7	3.7	0.1
Total Kjeldahl Nitrogen, % of dry wt.	0.19	0.19	0.04	0.02
Oil and Grease, % of dry wt.	0.17	0.27	0.17	0.03
Mercury (Hg), 10^{-4} % of dry wt.	0.7	1.3	1.3	0.4
Lead (Pb), 10^{-4} % of dry wt.	74	72	58	11
Zinc (Zn), 10^{-4} % of dry wt.	235	256	191	32
Cadmium (Cd), 10^{-4} % of dry wt.	0.2	1.1	1.5	0.5
Copper (Cu), 10^{-4} % of dry wt.	91	95	62	6



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	35.0-3_.5					
PT-2	3_.5-40.0					
PT-3	40.0-42.5					

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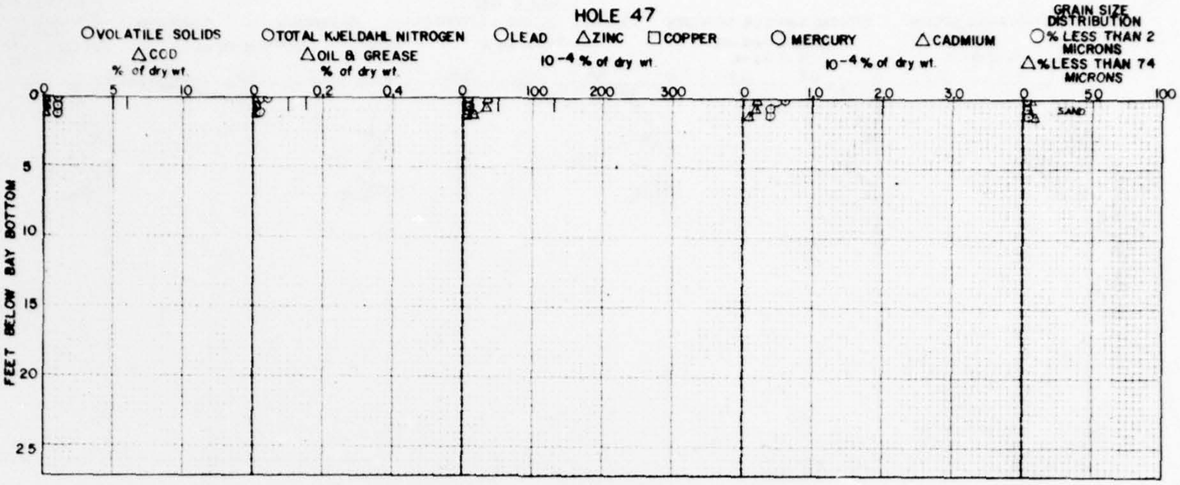
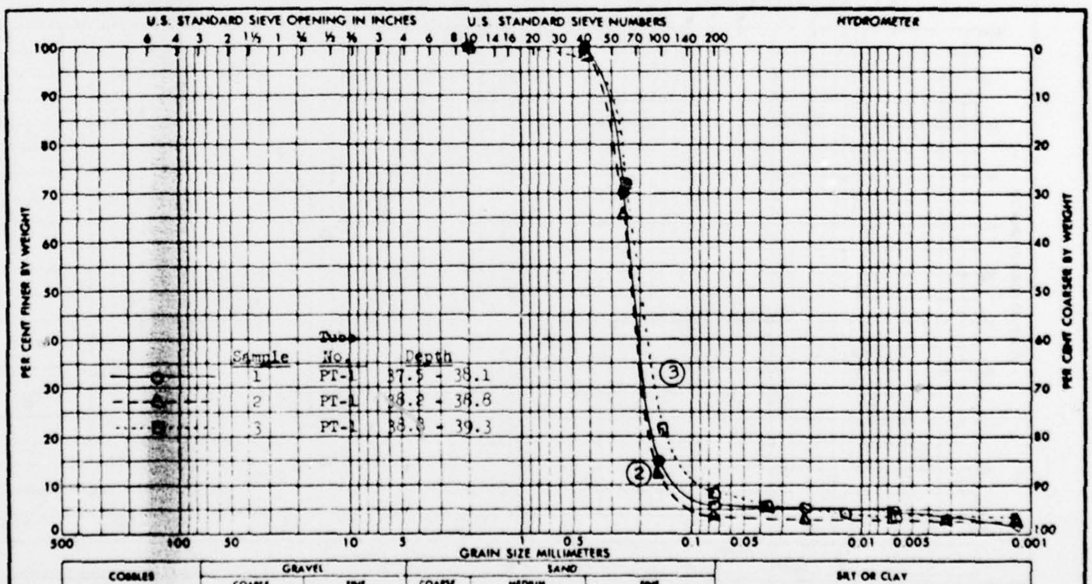


Hole No. 2D-101 (47)

Field Sample No.	PT-1	PT-1	PT-1
Laboratory Sample No.	1	2	3
Laboratory No.	PC-892	PC-893	PC-894
Volatile Solids, % of dry wt.	1.1	1.1	1.1
C.O.D., % of dry wt.	0.2	0.2	0.1
Total Kjeldahl Nitrogen, % of dry wt.	0.04	0.01	0.02
Oil and Grease, % of dry wt.	0.01-	0.01-	0.01-
Mercury (Hg), 10^{-4} % of dry wt.	0.6	0.4	0.4
Lead (Pb), 10^{-4} % of dry wt.	6	9	4
Zinc (Zn), 10^{-4} % of dry wt.	35	34	17
Cadmium (Cd), 10^{-4} % of dry wt.	0.2	0.2	0.1
Copper (Cu), 10^{-4} % of dry wt.	6	8	7



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	37.5 - 39.3					

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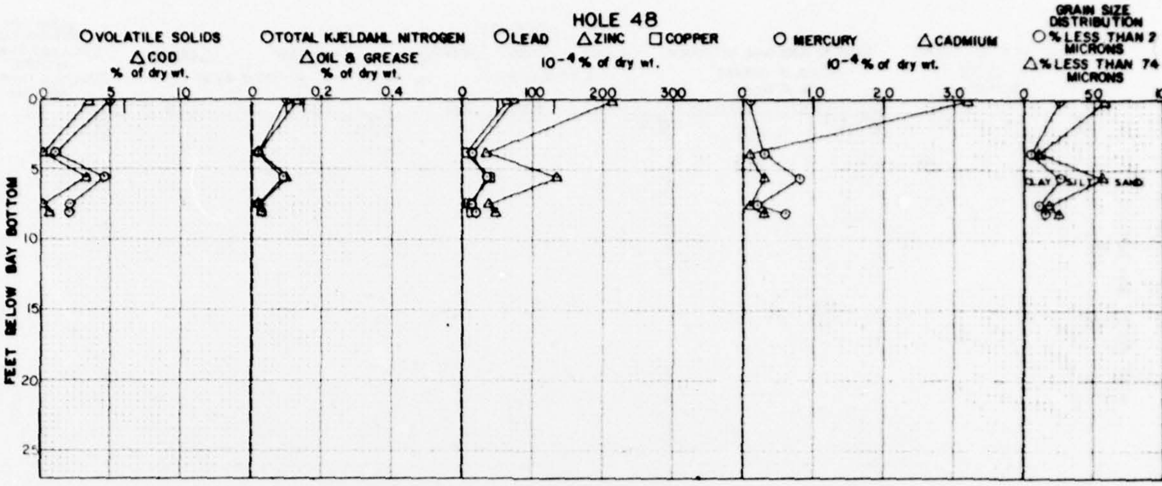
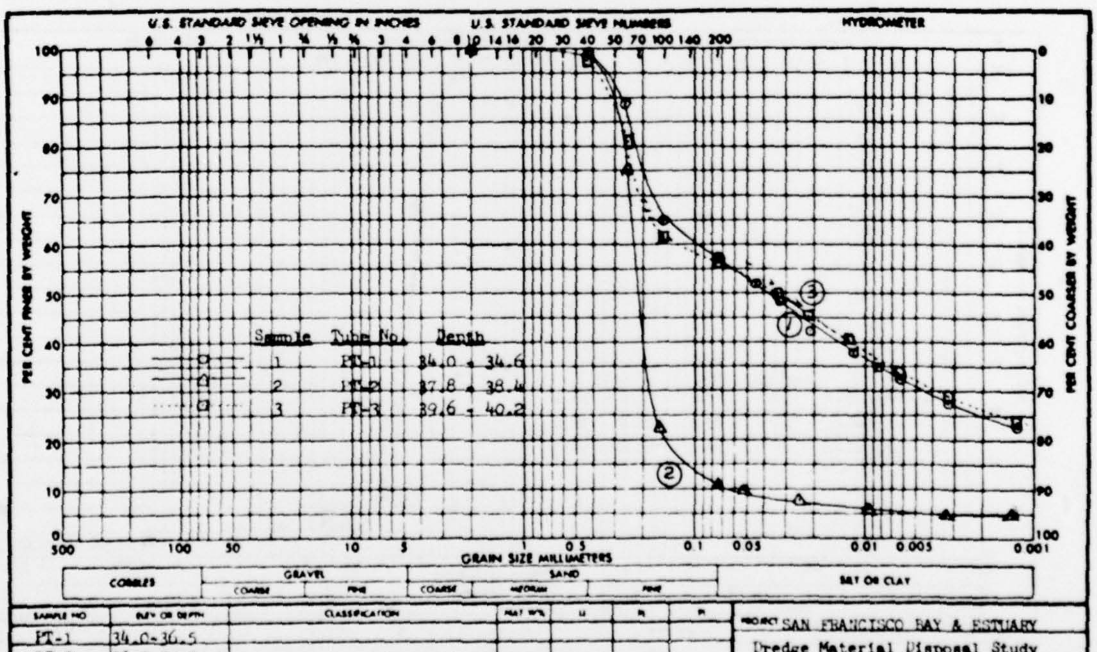


Hole No. 2D-98 (48)

Field Sample No.	PT-1	PT-2	PT-3	PT-4	PT-4
Laboratory Sample No.	1	2	3	4	5
Laboratory No.	PC-878	PC-879	PC-880	PC-881	PC-882
Volatile Solids, % of dry wt.	5.0	1.2	4.6	2.2	2.2
C.O.D., % of dry wt.	3.5	0.3	3.3	0.3	0.7
Total Kjeldahl Nitrogen, % of dry wt.	0.10	0.02	0.09	0.02	0.03
Oil and Grease, % of dry wt.	0.13	0.02	0.10	0.02	0.03
Mercury (Hg), 10^{-4} % of dry wt.	0.1	0.3	0.8	0.2	0.6
Lead (Pb), 10^{-4} % of dry wt.	73	15	35	13	20
Zinc (Zn), 10^{-4} % of dry wt.	213	34	134	38	48
Cadmium (Cd), 10^{-4} % of dry wt.	3.2	0.1	0.3	0.1	0.3
Copper (Cu), 10^{-4} % of dry wt.	64	7	40	10	14



SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
PT-1	34.0-36.5					
PT-2	36.5-39.0					
PT-3	39.0-41.5					

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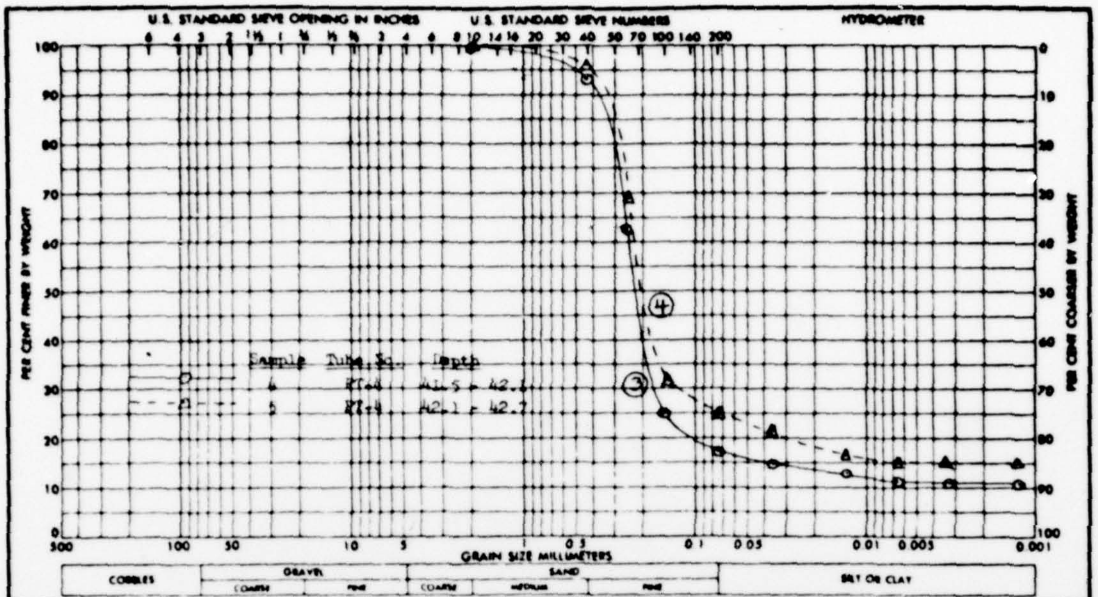

SAMPLE NO	ELEV OR DEPTH	CLASSIFICATION	NAT W%	LL	PL	PI
FT-4	41.5-44.0					

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